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VESTIGES

OF

THE NATURAL HISTORY

OF

CREATION.

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THE BODIES OF SPACE,

THEIR ARRANGEMENTS AND FORMATION.

It is familiar knowledge that the earth which we inhabit is a globe of somewhat less than 8000 miles in diameter, being one of a series of eleven which revolve at different distances around the sun, and some of which have satellites in like manner revolving around them. The sun, planets, and satellites, with the less intelligible orbs termed comets, are comprehensively called the solar system, and if we take as the uttermost bounds of this system the orbit of Uranus (though the comets actually have a wider range), we shall find that it occupies a portion of space not less than three thousand six hundred millions of miles in diameter. The mind fails to form an exact notion of a portion of space so immense; but some faint idea of it may be obtained from the fact, that, if the swiftest

race-horse ever known had begun to traverse it, at full speed, at the time of the birth of Moses, he would only as yet have accomplished half his journey.

It has long been concluded amongst astronomers, that the stars, though they only appear to our eyes as brilliant points, are all to be considered as suns, representing so many solar systems, each bearing a general resemblance to our own. The stars have a brilliancy and apparent magnitude which we may safely presume to be in proportion to their actual size and the distance at which they are placed from us. Attempts have been made to ascertain the distance of some of the stars by calculations founded on parallax, it being previously understood that, if a parallax of so much as one second, or the 3600th of a degree, could be ascertained in any one instance, the distance might be assumed in that instance as not less than 19,200,000 millions of miles! In the case of the most brilliant star, Sirius, even this minute parallax could not be found; from which of course it was to be inferred that the distance of that star is something beyond the vast distance which has been stated. In some others, on which the experiment has been tried, no sensible parallax could be detected; from

which the same inference was to be made in their case. But a sensible parallax of about one second has been ascertained in the case of the double star, α α, of the constellation of the Centaur,* and one of the third of that amount for the double star, 61 Cygni; which gave reason to presume that the distance of the former might be about nineteen millions of millions of miles, and the latter of much greater amount. If we suppose that similar intervals exist between all the stars, we shall readily see that the space occupied by even the comparatively small number visible to the naked eye must be vast beyond all powers of conception.

The number visible to the eye is about three thousand; but when a telescope of small power is directed to the heavens, a great number more come into view, and the number is ever increased in proportion to the increased power of the instrument. In one place, where they are more thickly sown than elsewhere, Sir William Herschel reckoned that fifty thousand passed over a field of view two degrees in breadth in a single hour. It was first surmised by the ancient philosopher, Democritus, that the faintly white zone which

* By the late Mr. Henderson, Professor of Astronomy in the Edinburgh University, and Lieutenant Meadows.

spans the sky under the name of the Milky Way, might be only a dense collection of stars too remote to be distinguished. This conjecture has been verified by the instruments of modern astronomers, and some speculations of a most remarkable kind have been formed in connexion with it. By the joint labours of the two Herschels, the sky has been "guaged" in all directions by the telescope, so as to ascertain the conditions of different parts with respect to the frequency of the stars. The result has been a conviction that, as the planets are parts of solar systems, so are solar systems parts of what may be called astral systems—that is, systems composed of a multitude of stars, bearing a certain relation to each other. The astral system to which we belong, is conceived to be of an oblong, flattish form, with a space wholly or comparatively vacant in the centre, while the extremity in one direction parts into two. The stars are most thickly sown in the outer parts of this vast ring, and these constitute the Milky Way. Our sun is believed to be placed in the southern portion of the ring, near its inner edge, so that we are presented with many more stars, and see the Milky Way much more clearly, in that direction, than towards the north, in which line our eye has

to traverse the vacant central space. Nor is this all. Sir William Herschel, so early as 1783, detected a motion in our solar system with respect to the stars, and announced that it was tending towards the star λ, in the constellation Hercules. This has been generally verified by recent and more exact calculations,* which fix on a point in Hercules, near the star 143 of the 17th hour, according to Piozzi's catalogue, as that towards which our sun is proceeding. It is, therefore, receding from the inner edge of the ring. Motions of this kind, through such vast regions of space, must be long in producing any change sensible to the inhabitants of our planet, and it is not easy to grasp their general character; but grounds have nevertheless been found for supposing that not only our sun, but the other suns of the system, pursue a wavy course round the ring *from west to east*, crossing and recrossing the middle of the annular circle. Some stars will depart more, others less, from either side of the circumference of equilibrium, according to the places in which they are situated, and according to the direction and the velocity with which they are put in motion. Our sun is

* Made by M. Argelander, late director of the Observatory at Abo.

probably one of those which depart furthest from it, and descend furthest into the empty space within the ring."* According to this view, a time may come when we shall be much more in the thick of the stars of our astral system than we are now, and have of course much more brilliant nocturnal skies; but it may be countless ages before the eyes which are to see this added resplendence shall exist.

The evidence of the existence of other astral systems besides our own is much more decided than might be expected, when we consider that the nearest of them must needs be placed at a mighty interval beyond our own. The elder Herschel, directing his wonderful tube towards the *sides* of our system, where stars are planted most rarely, and raising the powers of the instrument to the required pitch, was enabled with awe-struck mind to see suspended in the vast empyrean astral systems, or, as he called them, firmaments, resembling our own. Like light cloudlets to a certain power of the telescope, they resolved themselves, under a greater power, into stars, though these generally

* Professor Mossotti, on the Constitution of the Sidereal System, of which the Sun forms a part.—*London, Edinburgh, and Dublin Philosophical Magazine*, February, 1843.

seemed no larger than the finest particles of diamond dust. The general forms of these systems are various; but one at least has been detected as bearing a striking resemblance to the supposed form of our own. The distances are also various, as proved by the different degrees of telescopic power necessary to bring them into view. The farthest observed by the astronomer were estimated by him as thirty-five thousand times more remote than Sirius, supposing its distance to be about twenty millions of millions of miles. It would thus appear, that not only does gravitation keep our earth in its place in the solar system, and the solar system in its place in our astral system, but it also may be presumed to have the mightier duty of preserving a local arrangement between that astral system and an immensity of others, through which the imagination is left to wander on and on without limit or stay, save that which is given by its inability to grasp the unbounded.

The two Herschels have in succession made some other remarkable observations on the regions of space. They have found within the limits of our astral system, and generally in its outer fields, a great number of objects which, from their foggy appearance, are called *nebulæ;* some of vast ex-

tent and irregular figure, as that in the sword of Orion, which is visible to the naked eye; others of shape more defined; others, again, in which small bright nuclei appear here and there over the surface. Between this last form and another class of objects, which appear as clusters of nuclei with nebulous matter around each nucleus, there is but a step in what appears a chain of related things. Then, again, our astral space shows what are called nebulous stars,—namely, luminous spherical objects, bright in the centre and dull towards the extremities. These appear to be only an advanced condition of the class of objects above described. Finally, nebulous stars exist in every stage of concentration, down to that state in which we see only a common star with a slight *bur* around it. It may be presumed that all these are but stages in a progress, just as if, seeing a child, a boy, a youth, a middle-aged, and an old man together, we might presume that the whole were only variations of one being. Are we to suppose that we have got a glimpse of the process through which a sun goes between its original condition, as a mass of diffused nebulous matter, and its full-formed state as a compact body? We shall see how far such an idea is supported by

other things known with regard to the occupants of space, and the laws of matter.

A superficial view of the astronomy of the solar system gives us only the idea of a vast luminous body (the sun) in the centre, and a few smaller, though various sized bodies, revolving at different distances around it; some of these, again, having smaller planets (satellites) revolving around them. There are, however, some general features of the solar system which, when a profounder attention makes us acquainted with them, strike the mind very forcibly.

It is, in the first place, remarkable, that the planets all move nearly *in one plane*, corresponding with the centre of the sun's body. Next, it is not less remarkable, that the motion of the sun on its axis, those of the planets around the sun, and the satellites around their primaries,* and the motions of all on their axes, are *in one direction*—namely, from west to east. Had all these matters been left to accident, the chances against the uniformity which we find would have

* The orbitual revolutions of the satellites of Uranus have not as yet been clearly scanned. It has been thought that their path is retrograde compared with the rest. Perhaps this may be owing to a *bouleversement* of the primary, for the inclination of its equator to the ecliptic is admitted to be unusually high; but the subject is altogether so obscure, that nothing can be founded on it.

been, though calculable, inconceivably great. Laplace states them at four millions of millions to one. It is thus powerfully impressed on us, that the uniformity of the motions, as well as their general adjustment to one plane, must have been a consequence of some cause acting throughout the whole system.

Some of the other relations of the bodies are not less remarkable. The primary planets show a progressive increase of bulk and diminution of density, from the one nearest to the sun to that which is most distant. With respect to density alone, we find, taking water as a measure and counting it as one, that Saturn is $\frac{1}{3}\frac{3}{2}$, or less than half; Jupiter, $1\frac{1}{4}$; Mars, $3\frac{2}{7}$; Earth, $4\frac{1}{4}$; Venus, $5\frac{1}{3}$; Mercury, $9\frac{8}{10}$, or about the weight of lead. Then the distances are curiously relative. It has been found that if we place the following line of numbers,—

0 3 6 12 24 48 96 192,

and add 4 to each, we shall have a series denoting the respective distances of the planets from the sun. It will stand thus—

4	7	10	16	28	52	100	196
Merc.	Venus.	Earth.	Mars.		Jupiter.	Saturn.	Uranus.

It will be observed that the first row of figures

goes on from the second on the left hand in a succession of duplications, or multiplications by 2. Surely there is here a most surprising proof of the unity which I am claiming for the solar system. It was remarked when this curious relation was first detected, that there was the want of a planet corresponding to 28; the difficulty was afterwards considered as in a great measure overcome, by the discovery of four small planets revolving at nearly one mean distance from the sun, between Mars and Jupiter. The distances bear an equally interesting mathematical relation to the times of the revolutions round the sun. It has been found that, with respect to any two planets, the squares of the times of revolutions are to each other in the same proportion as the cubes of their mean distances,—a most surprising result, for the discovery of which the world was indebted to the illustrious Kepler. Sir John Herschel truly observes—"When we contemplate the constituents of the planetary system from the point of view which this relation affords us, it is no longer mere analogy which strikes us, no longer a general resemblance among them, as individuals independent of each other, and circulating about the sun, each according to its own peculiar nature, and con-

nected with it by its own peculiar tie. The resemblance is now perceived to be a true *family likeness;* they are bound up in one chain—interwoven in one web of mutual relation and harmonious agreement, subjected to one pervading influence, which extends from the centre to the farthest limits of that great system, of which all of them, the Earth included, must henceforth be regarded as members."*

Connecting what has been observed of the series of nebulous stars with this wonderful relationship seen to exist among the constituents of our system, and further taking advantage of the light afforded by the ascertained laws of matter, modern astronomers have suggested the following hypothesis of the formation of that system.

Of nebulous matter in its original state we know too little to enable us to suggest how nuclei should be established in it. But, supposing that, from a peculiarity in its constitution, nuclei are formed, we know very well how, by virtue of the law of gravitation, the process of an aggregation of the neighbouring matter to those nuclei should proceed, until masses more or less solid should become detached from the rest. It is a well-

* Astronomy, Cabinet Cyclopædia.

known law in physics that, when fluid matter collects towards or meets in a centre, it establishes a rotatory motion. See minor results of this law in the whirlwind and the whirlpool—nay, on so humble a scale as the water sinking through the aperture of a funnel. It thus becomes certain that when we arrive at the stage of a nebulous star, we have a rotation on an axis commenced.

Now, mechanical philosophy informs us that, the instant a mass begins to rotate, there is generated a tendency to fling off its outer portions—in other words, the law of centrifugal force begins to operate. There are, then, two forces acting in opposition to each other, the one attracting *to*, the other throwing *from*, the centre. While these remain exactly counterpoised, the mass necessarily continues entire; but the least excess of the centrifugal over the attractive force would be attended with the effect of separating the mass and its outer parts. These outer parts would then be left as a ring round the central body, which ring would continue to revolve with the velocity possessed by the central mass at the moment of separation, but not necessarily participating in any changes afterwards undergone by that body. This is a process which might be repeated as soon as a

new excess arose in the centrifugal over the attractive forces working in the parent mass. It might, indeed, continue to be repeated, until the mass attained the ultimate limits of the condensation which its constitution imposed upon it. From what cause might arise the periodical occurrence of an excess of the centrifugal force? If we suppose the agglomeration of a nebulous mass to be a process attended by refrigeration or cooling, which many facts render likely, we can easily understand why the outer parts, hardening under this process, might, by virtue of the greater solidity thence acquired, begin to present some resistance to the attractive force. As the solidification proceeded, this resistance would become greater, though there would still be a tendency to adhere. Meanwhile, the condensation of the central mass would be going on, tending to produce a separation from what may now be termed the *solidifying crust.* "During the contention between the attractions of these two bodies, or parts of one body, there would probably be a ring of attenuation between the mass and its crust. At length, when the central mass had reached a certain stage in its advance towards solidification, a separation would take place, and the crust would become a detached

ring. It is clear, of course, that some law presiding over the refrigeration of heated gaseous bodies would determine the stages at which rings were thus formed and detached. We do not know any such law, but what we have seen assures us it is one observing, and reducible to, mathematical formulæ.

If these rings consisted of matter nearly uniform throughout, they would probably continue each in its original form; but there are many chances against their being uniform in constitution. The unavoidable effects of irregularity in their constitution would be to cause them to gather towards centres of superior solidity, by which the annular form would, of course, be destroyed. The ring would, in short, break into several masses, the largest of which would be likely to attract the lesser into itself. The whole mass would then necessarily settle into a spherical form by virtue of the law of gravitation; in short, would become a planet revolving round the sun. Its rotatory motion would, of course, continue, and satellites might then be thrown off in turn from its body in exactly the same way as the primary planets had been thrown off from the sun. The rule, if I can be allowed so to call it, receives a striking

support from what appear to be its exceptions. While there are many chances against the matter of the rings being sufficiently equable to remain in the annular form till they were consolidated, it might nevertheless be otherwise in some instances; that is to say, the equableness might, in those instances, be sufficiently great. Such was probably the case with the two rings around the body of Saturn, which remain a living picture of the arrangement, if not the condition, in which all the planetary masses at one time stood. It may also be admitted that, when a ring broke up, it was possible that the fragments might spherify separately. Such seems to be the actual history of the ring between Jupiter and Mars, in whose place we now find four planets much beneath the smallest of the rest in size, and moving nearly at the same distance from the sun, though in orbits so elliptical, and of such different planes, that they keep apart.

It has been seen that there are mathematical proportions in the relative distances and revolutions of the planets of our system. It has also been suggested that the periods in the condensation of the nebulous mass, at which rings were disengaged, must have depended on some par-

ticular crises in the condition of that mass, in connexion with the laws of centrifugal force and attraction. M. Comte, of Paris, has made some approach to the verification of the hypothesis, by calculating what ought to have been the rotation of the solar mass at the successive times when its surface extended to the various planetary orbits. He ascertained that *that rotation corresponded in every case with the actual sidereal revolution of the planets, and that the rotation of the primary planets in like manner corresponded with the orbitual periods of the secondaries.* The process by which he arrived at this conclusion is not to be readily comprehended by the unlearned; but men of science allow that it is a powerful support to the present hypothesis of the formation of the globes of space.*

* M. Comte combined Huygens's theorems for the measure of centrifugal force with the law of gravitation, and thus formed a simple fundamental equation between the duration of the rotation of what he calls the producing star, and the distance of the star produced. The constants of this equation were the radius of the central star, and the intensity of gravity at its surface, which is a direct consequence of its mass. It leads directly to the third law of Kepler, which thus becomes susceptible of being conceived *à priori* in a cosmogonical point of view. M. Comte first applied it to the moon, and found, to his great delight, that the periodic time of that satellite agrees within an hour or two

The nebular hypothesis, as it has been called, obtains a remarkable support in what would at first seem to militate against it—the existence in our firmament of several thousands of solar systems, in which there are more than one sun. These are called double and triple stars. Some double stars, upon which careful observations have been made, are found to have a regular revolutionary motion round each other in ellipses. This

with the duration which the revolution of the earth ought to have had at the time when the lunar distance formed the limit of the earth's atmosphere. He found the coincidence less exact, but still very striking, in every other case. In those of the planets he obtained for the duration of the corresponding solar rotations a value always a little less than their actual periodic times. "It is remarkable," says he, "that this difference, though increasing as the planet is more distant, preserves very nearly the same relation to the corresponding periodic time, of which it commonly forms the forty-fifth part,"—shewing, we may suppose, that only some small elements of the question had been overlooked by the calculator. The defect changes to an excess in the different systems of the satellites, where it is proportionally greater than in the planets, and unequal in the different systems. "From the whole of these comparisons," says he, "I deduced the following general result:—Supposing the mathematical limit of the solar atmosphere successively extended to the regions where the different planets are now found, the duration of the sun's rotation was, at each of these epochs, sensibly equal to that of the actual sidereal revolution of the corresponding planet; and the same is true for each planetary atmosphere in relation to the different satellites."—*Cours de Philosophie Positif.*

kind of solar system has also been observed in what appears to be its rudimental state, for there are examples of nebulous stars containing two and three nuclei in near association. At a certain point in the confluence of the matter of these nebulous stars, they would all become involved in a common revolutionary motion, linked inextricably with each other, though it might be at sufficient distances to allow of each distinct centre having afterwards its attendant planets. We have seen that the law which causes rotation in the single solar masses, is exactly the same which produces the familiar phenomenon of a small whirlpool or dimple in the surface of a stream. Such dimples are not always single. Upon the face of a river where there are various contending currents, it may often be observed that two or more dimples are formed near each other with more or less regularity. These fantastic eddies, which the musing poet will sometimes watch abstractedly for an hour, little thinking of the law which produces and connects them, are an illustration of the wonders of binary and ternary solar systems.

The nebular hypothesis is, indeed, supported by so many ascertained features of the celestial scenery, and so many calculations of exact

science, that it may be considered as verging upon the region of our ascertained truths. Some further support I trust to bring to it; but in the meantime, assuming its truth, let us see what idea it gives of the constitution of what we term the universe, of the development of its various parts, and of its original condition.

Reverting to a former illustration—if we could suppose a number of persons of various ages presented to the inspection of an intelligent being newly introduced into the world, we cannot doubt that he would soon become convinced that men had once been boys, that boys had once been infants, and, finally, that all had been brought into the world in exactly the same circumstances. Precisely thus, seeing in our astral system many thousands of worlds in all stages of formation, from the most rudimental to that immediately preceding the present condition of those we deem perfect, it is unavoidable to conclude that all the perfect have gone through the various stages which we see in the rudimental. This leads us at once to the conclusion that the whole of our firmament was at one time a diffused mass of nebulous matter, extending through the space which it still

occupies. So also, of course, must have been the other astral systems. Indeed, we must presume the whole to have been originally in one connected mass, the astral systems being only the first division into parts, and solar systems the second.

The first idea which all this impresses upon us is, that the formation of bodies in space is *still and at present in progress.* We live at a time when many have been formed, and many are still forming. Our own solar system is to be regarded as completed, supposing its perfection to consist in the formation of a series of planets, for there are mathematical reasons for concluding that Mercury is the nearest planet to the sun, which can, according to the laws of the system, exist. But there are other solar systems within our astral system, which are as yet in a less advanced state, and even some quantities of nebulous matter which have scarcely begun to advance towards the stellar form. On the other hand, there are vast numbers of stars which have all the appearance of being fully formed systems, if we are to judge from the complete and definite appearance which they present to our vision through the telescope. We have no means of judging of the seniority of systems;

but it is reasonable to suppose that, among the many, some are older than ours. There is, indeed, one piece of evidence for the probability of the comparative youth of our system, altogether apart from human traditions and the geognostic appearances of the surface of our planet. This consists in a thin nebulous matter, which is diffused around the sun to nearly the orbit of Mercury, of a very oblately spheroidal shape. This matter, which sometimes appears to our naked eyes, at sunset, in the form of a cone projecting upwards in the line of the sun's path, and which bears the name of the Zodiacal Light, has been thought a residuum or last remnant of the concentrating matter of our system, and thus may be supposed to indicate the comparative recentness of the principal events of our cosmogony. Supposing the surmise and inference to be correct, and they may be held as so far supported by more familiar evidence, we might with the more confidence speak of our system as not amongst the elder born of Heaven, but one whose various phenomena, physical and moral, as yet lay undeveloped, while myriads of others were fully fashioned, and in complete arrangement. Thus, in the sublime chronology to which we are directing our inquiries, we first find ourselves called upon

to consider the globe which we inhabit as a child of the sun, elder than Venus and her younger brother Mercury, but posterior in date of birth to Mars, Jupiter, Saturn, and Uranus; next to regard our whole system as probably of recent formation in comparison with many of the stars of our firmament. We must, however, be on our guard against supposing the earth as a recent globe in our ordinary conceptions of time. From evidence afterwards to be adduced, it will be seen that it cannot be presumed to be less than many hundreds of centuries old. How much older Uranus may be, no one can tell, far less how much more aged may be many of the stars of our firmament, or the stars of other firmaments, than ours.

Another and more important consideration arises from the hypothesis; namely, as to the means by which the grand process is conducted. The nebulous matter collects around nuclei by virtue of the law of attraction. The agglomeration brings into operation another physical law, by force of which the separate masses of matter are either made to rotate singly, or, in addition to that single motion, are set into a coupled revolution in ellipses. Next centrifugal force comes into play, flinging off portions of the rotating masses, which

become spheres by virtue of the same law of attraction, and are held in orbits of revolution round the central body by means of a composition between the centrifugal and gravitating forces. All, we see, is done by certain laws of matter, so that it becomes a question of extreme interest, what are such laws? All that can yet be said, in answer, is, that we see certain natural events proceeding in an invariable order under certain conditions, and thence infer the existence of some fundamental arrangement which, for the bringing about of these events, has a force and certainty of action similar to, but more precise and unerring than those arrangements which human society makes for its own benefit, and calls laws. It is remarkable of physical laws, that we see them operating on every kind of scale as to magnitude, with the same regularity and perseverance. The tear that falls from childhood's cheek is globular, through the efficacy of that same law of mutual attraction of particles which made the sun and planets round. The rapidity of Mercury is quicker than that of Saturn, for the same reason that, when we wheel a ball round by a string, and make the string wind up round our fingers, the ball always flies quicker and quicker as

the string is shortened. Two eddies in a stream, as has been stated, fall into a mutual revolution at the distance of a couple of inches, through the same cause which makes a pair of suns link in mutual revolution at the distance of millions of miles. There is, we might say, a sublime simplicity in this indifference of the grand regulations to the vastness or minuteness of the field of their operation. Their being uniform, too, throughout space, as far as we can scan it, and their being so unfailing in their tendency to operate, so that only the proper conditions are presented, afford matter for the gravest consideration. Nor should it escape careful notice that the regulations on which all the laws of matter proceed, are established on a rigidly accurate mathematical basis. Proportions of numbers and geometrical figures rest at the bottom of the whole. All these considerations, when the mind is thoroughly prepared for them, tend to raise our ideas with respect to the character of physical laws, even though we do not go a single step further in the investigation. But it is impossible for an intelligent mind to stop there. We advance from law to the cause of law, and ask, What is that? Whence have come all these beautiful regulations? Here science leaves

us, but only to conclude, from other grounds, that there is a First Cause to which all others are secondary and ministrative, a primitive almighty will, of which these laws are merely the mandates. That great Being, who shall say where is his dwelling-place, or what his history! Man pauses breathless at the contemplation of a subject so much above his finite faculties, and only can wonder and adore!

CONSTITUENT MATERIALS OF THE EARTH

AND OF THE OTHER BODIES OF SPACE.

THE nebular hypothesis almost necessarily supposes matter to have originally formed one mass. We have seen that the same physical laws preside over the whole. Are we also to presume that the constitution of the whole was uniform?—that is to say, that the whole consisted of similar elements. It seems difficult to avoid coming to this conclusion, at least under the qualification that, possibly, various bodies, under peculiar circumstances attending their formation, may contain elements which are wanting, and lack some which are present, in others, or that some may entirely consist of elements in which others are entirely deficient.

What are elements? This is a term applied by

the chemist to a certain limited number of substances, (fifty-four or fifty-five are ascertained,) which, in their combinations, form all the matters of every kind present in and about our globe. They are called elements, or simple substances, because it has hitherto been found impossible to reduce them into others, wherefore they are presumed to be the primary bases of all matters. It has, indeed, been surmised that these so-called elements are only modifications of a primordial form of matter, brought about under certain conditions; but if this should prove to be the case, it would little affect the view which we are taking of cosmical arrangements. Analogy would lead us to conclude that the combinations of the primordial matter, forming our so-called elements, are as universal, or as liable to take place everywhere, as are the laws of gravitation and centrifugal force. We must therefore presume that the gases, the metals, the earths, and other simple substances, (besides whatever more of which we have no acquaintance,) exist or are liable to come into existence under proper conditions, as well in the astral system, which is thirty-five thousand times more distant than Sirius, as within the bounds of our own solar system or our own globe.

Matter, whether it consists of about fifty-five ingredients, or only one, is liable to infinite varieties of condition under different circumstances, or, to speak more philosophically, under different laws. As a familiar illustration, water, when subjected to a temperature under 32° Fahrenheit, becomes ice; raise the temperature to 212°, and it becomes steam, occupying a vast deal more space than it formerly did. The gases, when subjected to pressure, become liquids; for example, carbonic acid gas, when subjected to a weight equal to a column of water 1230 feet high, at a temperature of 32°, takes this form: the other gases require various amounts of pressure for this transformation, but all appear to be liable to it when the pressure proper in each case is administered. Heat is a power greatly concerned in regulating the volume and other conditions of matter. A chemist can reckon with considerable precision what additional amount of heat would be required to vaporise all the water of our globe; how much more to disengage the oxygen which is diffused in nearly a proportion of one-half throughout its solids; and, finally, how much more would be required to cause the whole to become vaporiform, which we may consider as equivalent to its being restored to its original

nebulous state. He can calculate with equal certainty what would be the effect of a considerable diminution of the earth's temperature — what changes would take place in each of its component substances, and how much the whole would shrink in bulk.

The earth and all its various substances have at present a certain volume in consequence of the temperature which actually exists. When, then, we find that its matter and that of the associate planets was at one time diffused throughout the whole space now circumscribed by the orbit of Uranus, we cannot doubt, after what we know of the power of heat, that the nebulous form of matter was attended by the condition of a very high temperature. The nebulous matter of space, previously to the formation of stellar and planetary bodies, must have been a universal Fire Mist, an idea which we can scarcely comprehend, though the reasons for arriving at it seem irresistible. The formation of systems out of this matter implies a change of some kind with regard to the condition of the heat. Had this power continued to act with its full original repulsive energy, the process of agglomeration by attraction

could not have gone on. We do not know enough of the laws of heat to enable us to surmise how the necessary change in this respect was brought about, but we can trace some of the steps and consequences of the process. Uranus would be formed at the time when the heat of our system's matter was at the greatest, Saturn at the next, and so on. Now this tallies perfectly with the exceeding diffuseness of the matter of those elder planets, Saturn being not more dense or heavy than the substance cork. It may be that a sufficiency of heat still remains in those planets to make up for their distance from the sun, and the consequent smallness of the heat which they derive from his rays. And it may equally be, since Mercury is twice the density of the earth, that its matter exists under a degree of cold for which that planet's large enjoyment of the sun's rays is no more than a compensation. Thus there may be upon the whole a nearly equal experience of heat amongst all these children of the sun. Where, meanwhile, is the heat once diffused through the system over and above what remains in the planets? May we not rationally presume it to have gone to constitute that luminous envelope

of the sun, in which his warmth-giving power is now held to reside? It may have simply been reserved to constitute, at the last, a means of sustaining the many operations of which the planets were destined to be the theatre.

The tendency of the whole of the preceding consideration is to bring the conviction that our globe is a specimen of all the similarly-placed bodies of space, as respects its constituent matter and the physical and chemical laws governing it, with only this qualification, that there are *possibly* shades of variation with respect to the component materials, and *undoubtedly* with respect to the conditions under which the laws operate, and consequently the effects which they produce. Thus, there may be substances here which are not in some other bodies, and substances here solid may be elsewhere liquid or vaporiform. We are the more entitled to draw such conclusions, seeing that there is nothing at all singular or special in the astronomical situation of the earth. It takes its place third in a series of planets, which series is only one of numberless other systems forming one group. It is strikingly—if I may use such an expression—a member of a democracy. Hence, we cannot suppose that there is any peculiarity about

it which does not probably attach to multitudes of other bodies—in fact, to all that are analogous to it in respect to cosmical arrangements.

It therefore becomes a point of great interest—what are the materials of this specimen? What is the constitutional character of this object, which may be said to be a sample, presented to our immediate observation, of those crowds of worlds which seem to us as the particles of the desert sand-cloud in number, and to whose diffusion there are no conceivable local limits?

The solids, liquids, and aeriform fluids of our globe are all, as has been stated, reducible into fifty-five substances hitherto called elementary. Of these, forty are well-characterized metals, twelve non-metallic bodies, and the remaining three solid substances of intermediate character, which form a connecting link between the two great groups. Among the non-metallic elements, four, viz., oxygen, hydrogen, nitrogen, and chlorine, are permanently gaseous; bromine is fluid at common temperatures; and the remainder (with the exception of fluorine, which has never been isolated, and whose physical characters are consequently unknown) are solid.

The body oxygen is considered as by far the

most abundant substance in our globe. It constitutes a fifth part of our atmosphere, eight-ninths of the weight of water, and a large proportion of every kind of rock in the crust of the earth. Hydrogen, which forms the remaining part of water, and enters into some mineral substances, is perhaps next. Nitrogen, of which the atmosphere is four-fifths composed, must be considered as an abundant substance. The metal silicium, which unites with oxygen in nearly equal parts to form silica, the basis of nearly a half of the rocks in the earth's crust, is, of course, an important ingredient. Aluminium, the metallic basis of alumina, a large material in many rocks, is another abundant elementary substance. So, also, is carbon, a small ingredient in the atmosphere, but the chief constituent of animal and vegetable substances, and of all fossils which ever were in the latter condition, amongst which coal takes a conspicuous place. The familiarly-known metals, as iron, tin, lead, silver, gold, are elements of comparatively small magnitude in that exterior part of the earth's body which we are able to investigate.

It is remarkable of the simple substances that they are generally in some compound form. Thus, oxygen and nitrogen, though in mixture they form

the aerial envelope of the globe, are never found separate in nature. Carbon is pure only in the diamond. And the metallic bases of the earths, though the chemist can disengage them, may well be supposed unlikely to remain long uncombined, seeing that contact with moisture makes them burn. Combination and re-combination are principles largely pervading nature. There are few rocks, for example, that are not composed of at least two varieties of matter, each of which is again a compound of elementary substances. What is still more wonderful with respect to this principle of combination, all the elementary substances observe certain mathematical proportions in their unions. When in the gaseous state, one volume of them unites with one, two, three, or more volumes of another, any extra quantity being sure to be left over, if such there should be. Combinations by weight are also governed by fixed and unchanging laws, of the greatest beauty and simplicity. It is hence supposed by some that matter is composed of infinitely minute particles or atoms, each of which belonging to any one substance, can only (through the operation of some as yet hidden law) associate with a certain number of the atoms of any other. There are also strange predilections

amongst substances for each other's company. One will remain combined in solution with another, till a third is added, when it will abandon the former and attach itself to the latter. A fourth being added, the third will perhaps leave the first, and join the new comer.

Such is an outline of the information which chemistry gives us regarding the constituent materials of our globe. How infinitely is the knowledge increased in interest, when we consider the probability of such being the materials of the whole of the bodies of space, and the laws under which these everywhere combine, subject only to local and accidental variations!

In considering the cosmogonic arrangements of our globe, our attention is called in a special degree to the moon.

In the nebular hypothesis, satellites are considered as masses thrown off from their primaries, exactly as the primaries had previously been from the sun. The orbit of any satellite is also to be regarded as marking the bounds of the mass of the primary at the time when that satellite was thrown off; its speed likewise denotes the rapidity of the rotatory motion of the primary at that particular juncture. For example, the outermost of

the four satellites of Jupiter revolves round his body at the distance of 1,180,582 miles, shewing that the planet was once about 3,675,501 miles in circumference, instead of being, as now, only 89,170 miles in diameter. This large mass took rather more than sixteen days six hours and a half (the present revolutionary period of the outermost satellite) to rotate on its axis. The innermost satellite must have been formed when the planet was reduced to a circumference of 309,075 miles, and rotated in about forty-two hours and a half.

From similar inferences, we find that the mass of the earth, at a certain point of time after it was thrown off from the sun, was no less than 482,000 miles in diameter, being sixty times what it has since shrunk to. At that time, the mass must have taken rather more than twenty-nine and a half days to rotate, (being the revolutionary period of the moon,) instead of as now, rather less than twenty-four hours.

The time intervening between the formation of the moon and the earth's diminution to its present size, was probably one of those vast sums in which astronomy deals so largely, but which the mind altogether fails to grasp.

The observation made upon the surface of the

moon by telescopes tends strongly to support the hypothesis as to all the bodies of space being composed of similar matters subject to certain variations. It does not appear that our satellite is provided with that gaseous envelope which, on earth, performs so many important functions. Neither is there any appearance of water upon the surface; yet that surface is, like that of our globe, marked by inequalities and the appearance of volcanic operations. These inequalities and volcanic operations are upon a scale far greater than any which now exist upon the earth's surface. Although, from the greater force of gravitation upon its exterior, the mountains, other circumstances being equal, might have been expected to be much smaller than ours, they are, in many instances, equal in height to nearly the highest of our Andes. They are generally of extreme steepness, and sharp of outline, a peculiarity which might be looked for in a planet deficient in water and atmosphere, seeing that these are the agents which wear down ruggedness on the surface of our earth. The volcanic operations are on a stupendous scale. They are the cause of the bright spots of the moon, while the want of them is what distinguishes the duller portions, usually

but erroneously called *seas*. In some parts, bright volcanic matter, besides covering one large patch, radiates out in long streams, which appear studded with subordinate *foci* of the same kind of energy. Other objects of a most remarkable character are ring-mountains, mounts like those of the craters of earthly volcanoes, surrounded immediately by vast and profound circular pits, hollowed under the general surface, these again being surrounded by a circular wall of mountain, rising far above the central one, and in the inside of which are terraces about the same height as the inner eminence. The well-known bright spot in the south-east quarter, called by atsronomers *Tycho*, and which can be readily distinguished by the naked eye, is one of these ring-mountains. There is one of 200 miles in diameter, with a pit of 22,000 feet deep; that is, twice the height of Etna. It is remarkable, that the maps given by Humboldt of a volcanic district in South America, and one illustrative of the formerly volcanic district of Auvergne, in France, present features strikingly like many parts of the moon's surface, as seen through a good glass.

These characteristics of the moon forbid the idea that it can be at present a theatre of life like the

earth, and almost seem to declare that it never can become sc. [illegible] we must not rashly draw any such conclus[illegible]. The moon may be only in an earlier stage of the progress through which the earth has already gone. The elements which seem wanting may be only in combinations different from those which exist here, and may yet be developed as we here find them. Seas may yet fill the profound hollows of the surface; an atmosphere may spread over the whole. Should these events take place, meteorological phenomena, and all the phenomena of organic life, will commence, and the moon, like the earth, will become a green and inhabited world.*

* Among the most extraordinary phenomena of natural science must be placed those relating to the fall of *meteoric stones*. The fact itself, so long doubted, has now been established by an accumulation of the most positive and unexceptionable evidence. The stones have been seen to fall, and taken up in a still heated state;—there can be no manner of doubt about the fact, although the explanation is extremely difficult. All these stones are found on examination to resemble each other in their general characters; they usually consist of an earthy material, having disseminated through its substance globules and small masses of metallic iron containing nickel in the state of alloy. The stones are often covered by a thin vitreous crust, as if partial fusion had commenced. It is well known, also, that large masses of soft, malleable iron, also containing nickel, are found in several places far removed from each other, lying loose upon the earth, as in South America and in Siberia, and no doubt can exist of

It is unavoidably held as a strong proof in favour of any hypothesis, when all the relative phenomena are in harmony with it. This is eminently the case with the nebulous hypothesis, for here the associated facts cannot be explained on any other supposition. We have seen reason to conclude that the primary condition of matter was that of a diffused mass, in which the component molecules were probably kept apart through the efficacy of heat; that portions of this agglome-

the meteoric origin of these masses. It has been conjectured that these meteoric stones proceed from the moon, having been shot out from volcanoes with such violence as to be brought within the reach of the earth's attraction. A view now more general supposes the existence in space of very numerous small bodies, moving in more or less regular orbits around the sun and larger planets, which at certain periods undergo such perturbation that their motion becomes completely deranged, and they at length fall upon the surface of the earth or other planet, whose attraction has been the exciting cause of the derangement of their orbits. Whatever may be their real origin, they are by common consent looked upon as foreign to the earth; their physical constitution is completely different from any known minerals. But what is exceedingly remarkable, and particularly worthy of notice as strengthening the argument that all the members of the solar system, and perhaps of other systems, have a similar constitution, *no new elements* are found in these bodies; they contain the ordinary materials of the earth, but associated in a manner altogether new, and unlike anything known in terrestrial mineralogy.—*Note by a Correspondent.*

rated into suns, which threw off planets; that these planets were at first very much diffused, but gradually contracted by cooling to their present dimensions. Now, as to our own globe, there is a remarkable proof of its having been in a fluid state at the time when it was finally solidifying, in the fact of its being bulged at the equator, the very form which a soft revolving body takes, and must inevitably take, under the influence of centrifugal force. This bulging makes the equatorial exceed the polar diameter as 230 to 229, which has been demonstrated to be precisely the departure from a correct sphere which might be predicted from a knowledge of the amount of the mass and the rate of rotation. There is an almost equally distinct memorial of the original high temperature of the materials in the store of heat which still exists in the interior. The immediate surface of the earth, be it observed, exhibits only the temperature which might be expected to be imparted to such materials by the heat of the sun. There is a point a very short way down, but varying in different climes, where all effect from the sun's rays ceases. Then commences a temperature from an entirely different cause, one which evidently has its source in the

interior of the earth, and which regularly increases as we descend to greater and greater depths, the rate of increment being about one degree Fahrenheit for every sixty feet; and of this high temperature there are other evidences, in the phenomena of volcanoes and thermal springs, as well as in what is ascertained with regard to the density of the entire mass of the earth. This, it will be remembered, is four and a half times the weight of water; but the actual weight of the principal solid substances composing the outer crust is as two and a half times the weight of water; and this, we know, if the globe were solid and cold, should increase vastly towards the centre, water acquiring the density of quicksilver at 362 miles below the surface, and other things in proportion, and these densities becoming much greater at greater depths; so that the entire mass of a cool globe should be of a gravity infinitely exceeding four and a half times the weight of water. The only alternative supposition is, that the central materials are greatly expanded or diffused by some means; and by what means could they be so expanded but by heat? Indeed, the existence of this central heat, a residuum of that which kept

all matter in a vaporiform chaos at first, is amongst the most solid discoveries of modern science,* and the support which it gives to Herschel's explanation of the formation of worlds is highly important. We shall hereafter see what appear to be traces of an operation of this heat upon the surface of the earth in very remote times; an effect, however, which has long passed entirely away. The central heat has, for ages, reached a fixed point, at which it will probably remain for ever, as the non-conducting quality of the cool crust absolutely prevents it from suffering any diminution.

* The researches on this subject were conducted chiefly by the late Baron Fourier, perpetual secretary to the Academy of Sciences of Paris. See his *Théorie Analytique de la Chaleur*, 1822.

THE EARTH FORMED—ERA OF THE PRIMARY ROCKS.

ALTHOUGH the earth has not been actually penetrated to a greater depth than three thousand feet, the nature of its substance can, in many instances, be inferred for the depth of many miles by other means of observation. We see a mountain composed of a particular substance, with strata, or beds of other rock, lying against its sloped sides; we, of course, infer that the substance of the mountain dips away under the strata which we see lying against it. Suppose that we walk away from the mountain across the turned up edges of the stratified rocks, and that for many miles we continue to pass over other stratified rocks, all disposed in the same way, till by and by we come to a place where we begin to cross the opposite edges of the

same beds; after which we pass over these rocks all in reverse order till we come to another extensive mountain composed of similar material to the first, and shelving away under the strata in the same way. We should then infer that the stratified rocks occupied a basin formed by the rock of these two mountains, and by calculating the thickness right through these strata, could say to what depth the rock of the mountain extended below. By such means, the kind of rock existing many miles below the surface can often be inferred with considerable confidence.

The interior of the globe has now been inspected in this way in many places, and a tolerably distinct notion of its general arrangements has consequently been arrived at. It appears that the basis rock of the earth, as it may be called, is of hard texture, and crystalline in its constitution. Of this rock, granite may be said to be the type, though it runs into many varieties. Over this, except in the comparatively few places where it projects above the general level in mountains, other rocks are disposed in sheets or strata, with the appearance of having been deposited originally from water. But these last rocks have nowhere been allowed to rest in their original arrangement.

Uneasy movements from below have broken them up in great inclined masses, while in many cases there has been projected through the rents rocky matter more or less resembling the great inferior crystalline mass. This rocky matter must have been in a state of fusion from heat at the time of its projection, for it is often found to have run into and filled up lateral chinks in these rents. There are even instances where it has been rent again, and a newer melted matter of the same character sent through the opening. Finally, in the crust as thus arranged, there are, in many places, chinks containing veins of metal. Thus, there is first a great inferior mass, composed of crystalline rock, and probably resting immediately on the fused and expanded matter of the interior: next, layers or strata of aqueous origin; next, irregular masses of melted inferior rock that have been sent up volcanically and confusedly at various times amongst the aqueous rocks, breaking up these into masses, and tossing them out of their original levels. This is an outline of the arrangements of the crust of the earth, as far as we can observe it. It is, at first sight, a most confused scene; but after some careful observation, we readily detect in it a regularity and order from

which much instruction in the history of our globe is to be derived.

The deposition of the aqueous rocks, and the projection of the volcanic, have unquestionably taken place since the settlement of the earth in its present form. They are indeed of an order of events which we see going on, under the agency of intelligible causes, down to the present day. We may therefore consider them generally as comparatively recent transactions. Abstracting them from the investigations before us, we arrive at the idea of the earth in its first condition as a globe of its present size—namely, as a mass, externally at least, consisting of the crystalline kind of rock, with the waters of the present seas and the present atmosphere around it, though these were probably in considerably different conditions, both as to temperature and their constituent materials, from what they now are. We are thus to presume that that crystalline texture of rock which we see exemplified in granite is the condition into which the great bulk of the solids of our earth were agglomerated directly from the nebulous or vapori-form state. It is a condition eminently of combination, for such rock is invariably composed of two or more of four substances—silica, mica, quartz, and

hornblende—which associate in it in the form of grains or crystals, and which are themselves each composed of a group of the simple or elementary substances.

Judging from the results and from still remaining conditions, we must suppose that the heat retained in the interior of the globe was more intense, or had greater freedom to act in some places than in others. These became the scenes of volcanic operations, and in time marked their situations by the extrusion of traps and basalts from below—namely, rocks composed of the crystalline matter fused by intense heat, and developed on the surface in various conditions, according to the particular circumstances under which it was sent up; some, for example, being thrown up under water, and some in the open air, which contingencies are found to have made considerable difference in its texture and appearance. The great stores of subterranean heat also served an important purpose in the formation of the aqueous rocks. These rocks might, according to Sir John Herschel, become subject to heat in the following manner:—While the surface of a particular mass of rock forms the bed of the sea, the heat is kept at a certain distance from that surface by the con-

tact of the water; philosophically speaking, the mass radiates away the heat into the sea, and (to resort to common language) is cooled a good way down. But when new sediment settles at the bottom of that sea, the heat rises up to what was formerly the surface; and when a second quantity of sediment is laid down, it continues to rise through the first of the deposits, which then becomes subjected to those changes which heat is calculated to produce. This process is precisely the same as that of putting additional coats upon our own bodies; when, of course, the internal heat rises through each coat in succession, and the third (supposing there is a fourth above it) becomes as warm as perhaps the first originally was.

In speaking of sedimentary rocks, we may be said to be anticipating. It is necessary, first, to shew how such rocks were formed, or how stratification commenced.

Geology tells us as plainly as possible, that the original crystalline mass was not a perfectly smooth ball, with air and water playing round it. There were irregularities in the surface,—irregularities, trifling, perhaps, compared with the whole bulk of the globe, but probably larger than any which now exist upon it. These irregularities

might be occasioned by inequalities in the cooling of the substance, or by accidental and local sluggishness of the materials, or by local effects of the concentrated internal heat. From whatever cause they arose, there they were—granitic mountains, interspersed with seas which sunk to a great depth, and by which, perhaps, the mountains were wholly or partially covered. Now, it is a fact of which the very first principles of geology assure us, that the solids of the globe cannot for a moment be exposed to water, or to the atmosphere, without becoming liable to change. They instantly begin to wear down. This operation, we may be assured, proceeded with as much certainty in the earliest ages of our earth's history, as it does now, but probably upon a much more magnificent scale. The matters worn off, being carried into the neighbouring depths, and there deposited, became the components of the earliest stratified rocks, the first series of which is the *Gneiss and Mica Slate System*, or series, examples of which are exposed to view in the Highlands of Scotland and in the West of England. We have evidence that the earliest strata were formed in the presence of a stronger degree of heat than what operated in subsequent stages of the world, for the laminæ of the gneiss

and of the mica and chlorite schists are contorted in a way which could only be the result of a very high temperature. It appears as if the seas in which these deposits were formed, had been in the troubled state of a caldron of water nearly at boiling heat. Such a condition would probably add not a little to the disintegrating power of the ocean.

The earliest stratified rocks contain no matters which are not to be found in the primitive granite. They are the same in material, but only changed into new forms and combinations; hence they have been called by Mr. Lyell, metamorphic rocks. But how comes it that some of them are composed almost exclusively of one of the materials of granite; the mica schists, for example, of mica—the quartz rocks, of quartz, &c.? For this there are both chemical and mechanical causes. Suppose that a river has a certain quantity of material to carry down, it is evident that it will soonest drop the larger particles, and carry the lightest farthest on. To such a cause is it owing that some of the materials of the worn down granite have settled in one place and some in another.* Again, some of these materials must be presumed

* De la Beche's Geological Researches.

to have been in a state of chemical solution in the primeval seas. It would be of course in conformity with chemical laws, that certain of these materials would be precipitated singly, or in modified combinations, to the bottom, so as to form rocks by themselves.

COMMENCEMENT OF ORGANIC LIFE—SEA PLANTS, CORALS, ETC.

FROM the Primary Rocks, we pass into a group called the *Clay Slate and Grauwacké Slate System*, which, however, is found in some places resting immediately on the granite, the primary bed being there wanting. This system is largely developed in the west and north of England, and it has been well examined, partly because some of the slate beds are extensively quarried for domestic purposes. The sub-divisions are in the following order, beginning with the lowest:—1, hornblende slate; 2, chiastolite slate; 3, clay slate; 4, Snowdon rocks (grauwacké and conglomerates).

Hitherto nothing has been said of the fossils which constitute so important a part of geological science. It is now to be observed that, from an

early portion of the rock series to its close, the mineral masses are found to enclose remains of the organic beings (plants and animals) which flourished upon earth during the time when those were forming; and these organisms, or such parts of them as were of sufficient solidity, have been in many instances preserved with the utmost fidelity, although for the most part converted into the substance of the enclosing mineral. The rocks may be said thus to form a kind of history of the organic departments of nature from perhaps near its beginning to the present time. This is a piece of knowledge entirely new to man, and it may be safely said that he has never made a merely intellectual acquisition of a more interesting or remarkable nature. I am to trace this history as well as existing materials will permit.

We might well suppose that it would be with a kind of awe that the first investigators of fossilology would learn what were the earliest forms of animated being of which we have any record as existing upon this globe, where since so much has been enjoyed and suffered by the various vessels of life, of sensation, and of thought. They might look in upon the scene ready for their inspection, with fear and veneration; but, behold, nature is

simpler than man's wit would make her, and the beings presented to our view are of orders which we are accustomed to consider as playing but a humble part upon this world. We find at this time no land animals, none which could breathe the atmosphere, none but tenants of the water; and even animals so high as fish were entirely wanting. In popular language, we might say the earliest fossils are corals and shell-fish.

The humblest are polypiaria and crinoidea, members of the first division of the animal kingdom, according to Cuvier, namely, the Radiata. Along with them are a few lowly genera of crustacea, one of the great classes of the next higher division, the Articulata; also brachiopoda and conchifera, which belong to the next higher again, the Mollusca. To descend to a few particulars:—The polypiaria include various forms of those extraordinary animals (corallines) which abound to such a degree in tropical seas of the present day, often obstructing the course of the mariner, and even laying the foundations of new continents. The crinoids are an early and simple form of the large family of echinodermata (star-fishes), also very abundant in the present day; the animal, though composed of innumerable minute calca-

reous masses, connected by a gelatinous substance, is merely a stomach surrounded by tentacula, to provide itself with food, and mounted upon a many-jointed stalk, so as to bear a considerable resemblance to a flower growing on its stem. Of the crustacea of the system, the most remarkable are trilobites,—animals which continued to flourish in a great variety of species throughout several of the subsequent rock-formations, but which are now only faintly represented in a few obscure species. Some curious inferences have been made by Dr. Buckland, from the prominent facet-covered eyes with which this creature was furnished, indicating that the sea in which it lived was a clear medium, as existing seas generally are, and that light was the same in character in those inconceivably remote ages as it is now.

That such, however, were the first sole examples of life which existed upon the earth, it is impossible to believe. We see such animals in the present day requiring smaller and simpler animals for their subsistence; and tracing, again, the economy of these smaller animals, we find that they depend for nutriment either upon animals still more minute than themselves, or upon some equally small and impalpable forms of vegetation,

which the bountiful hand of nature has placed within their reach. The crustacea, then, the mollusks, and radiates of the Slate System, necessarily imply the previous, or at least contemporary existence of certain humbler forms of life, vegetable as well as animal; forming a scene, indeed, much like what is found in seas of the present day, excepting that neither fishes nor any higher vertebrata as yet roamed through the marine wilds. That no remains of such plants and animals have been preserved for our examination, is precisely what might have been expected, for their forms were of such a soft consistence, as not to have had more than perhaps a very slight chance of leaving memorials of themselves in rocks of any kind, more particularly rocks which are believed to have been subjected, in their formation, to an unusual degree of heat. It is not conceivable that confervæ, or any other simple forms of marine vegetation, that soft animalcules, or spongiæ, or acalephæ, could have preserved shape or consistence in the mud at the bottoms of those seas, till that mud had been baked into rock. Their non-appearance, therefore, is eminently one of those negative phenomena on which it is held by sound geologists as unsafe to build conclusions. There are, nevertheless, some appearances in the primary

rocks, which may be said to betray the existence of organic life in that age. In those rocks, "fragments apparently organic, and resembling the cases of infusoria, [shelled animalcules,]" have been detected.* This is also what might have been expected, seeing that these infusoria, though of the humblest form of animal being, possessed hard parts capable of being preserved. The existence of remains of animals in the primary rocks has been inferred by Braconnot, from his finding ammoniacal and combustible products on distilling portions of them in porcelain retorts. It is also to be remarked that, amidst the primary rocks, there are a few patches of limestone, forming rather an exceptive or local, than a general phenomenon. Limestone (carbonate of lime) contains an element (carbon) which we have no reason to believe to have existed in the rock from which the primaries were derived. It is a challengeable stranger upon the face of the earth, and extremely important to the present question, in as far as it is the principal constituent of organic substance of almost every kind. Plants take in this substance from the atmosphere, where it is a subordinate ingredient; marine polypes appropriate it, in connexion with lime, from the waters of the ocean, provided it be

* Ansted's Geology, ii. 60.

there in solution; and this compound substance do these animals deposit in the far extending masses which have been alluded to. It is fully ascertained of many strata of limestone higher in the series, that they are merely coralline accumulations, changed by subjection to heat and pressure. It is evident, then, that, though we do not find incontestable relics of distinct animals or plants below the Slate System, there is every reason to suppose that life began at an earlier period, and in forms of a kind humbler than many of those found in that portion of the rock series.*

It is to be remarked of the fossils of the Slate System that, though they can readily be referred to existing *orders*, the species and even genera to which they belonged, are no longer found on earth; nay, almost the whole had become extinct before the next group of strata was formed. Such changes of species we shall find to be of frequent occurrence throughout the subsequent ages. It may

* It has been stated that the Gneiss and Mica system in Bohemia includes some seams of grauwacké, in which are organic remains. To this announcement British geologists have not as yet attached much importance. Dr. M'Culloch found, as he believed, fossil orthocerata in the Gneiss tract of Loch Eribol, in Sutherland; but Messrs. Sedgwick and Murchison, on a subsequent search, could not verify the discovery.

also be observed that the fossils of the slate system are at once few in number of species, and rare as individual specimens. There are not more than thirty of them altogether, and it has been said that a geologist may travel thirty miles before he would collect specimens to an equal amount.

Ascending to the next group of rocks, we find the traces of life become more abundant, the number of species extended, and important additions made in vestiges of fuci, or sea plants, and of fishes. This group of rocks has been called by English geologists, the *Silurian System*, because largely developed at the surface of a district of western England, formerly occupied by a people whom the Roman historians call Silures. It is a series of sandstones, limestones, and beds of shale (hardened mud), which are classed in the following sub-groups, beginning with the undermost:— 1, Llandeilo rocks, (darkish calcareous flagstones;) 2 and 3, two groups called Caradoc rocks; 4, Wenlock shale; 5, Wenlock limestone; 6, Lower Ludlow rocks, (shales and limestones;) 7, Aymestry limestone; 8, Upper Ludlow rocks, (shales and limestone, chiefly micaceous.) While thus esteemed as mineralogically different from the preceding system, it is, zoologically, or with respect to fossils, only a continuation of it: that is to say, we here

find animals generally similar to those presented in the inferior rocks, although with the addition of certain new forms. From the lowest beds upwards, there are polypiaria, though most prevalent in the Wenlock limestones; trilobites; brachiopodous mollusks, a vast number of genera, (including terebratula, pentamerus, spirifer, orthis, leptæna;) gasteropoda; cephalopoda, of several orders and many genera, (including turritella, orthoceras, nautilus, bellerophon.) The cephalopoda (represented in our era by the nautilus, cuttle-fish, &c.) are the most highly organized of the mollusca, possessing in some families an internal osseous skeleton, together with a heart, and a head presenting mandibles not unlike those of a parrot. This class was eminently carnivorous, and acted the part of a police in keeping down the redundant life of the early seas.*

* In marking the gasteropods and cephalopods as coming in with the Silurian rocks, I followed the authority of Professor Phillips, who, in his Treatise on Geology (1839), says, with regard to the primaries and clay slate system, "No gasteropods or cephalopods are as yet mentioned in these rocks in Britain." After the above text had been re-written for the present edition, I find two or three examples of these classes of mollusks introduced in the slate rocks, in a table of that formation, prepared from recent observation by Messrs. Salter and De Carle Sowerby, in the Quarterly Journal of the Geological Society, No. I. (Feb. 1845.)

A little above the Llandeilo rocks, there have been discovered certain convoluted forms, which are now established as annelides, or sea-worms, a tribe of creatures still existing, (nereidina and serpulina,) and which may often be found beneath stones on a sea-beach. One of these, figured by Mr. Murchison, is furnished with feet in vast numbers all along its body, like a centipede. The occurrence of annelides is important, on account of their character and status in the animal kingdom. They are red-blooded and hermaphrodite, and form a link of connexion between the annulosa (white-blooded worms) and a humble class of the vertebrata.* The Wenlock limestone is the most remarkable amongst all the rocks of the Silurian system, for organic remains. Many slabs of it are wholly composed of corals, shells, and trilobites, held together by shale. It contains many genera of crinoidea and polypiaria, and there is little reason to doubt that some beds of it are wholly the production of the latter creatures, or are, in other words, coral reefs transformed by heat and pressure into rocks. Remains of fishes, of a very minute size, have been detected by Mr. Phillips in rocks immediately over the Aymestry limestone, being

* The inferiorly organized fishes, amphioxus and myxene.

apparently the first examples of vertebrated animals which breathed upon our planet. In the upper Ludlow rocks, remains of six genera, of obscure character, have been for a longer period known.

The traces of fuci in this system are all but sufficient to allow of a distinction of genera. In some parts of North America, extensive though thin beds of them have been found. A distinguished French geologist, M. Brongniart, has shewn that all existing marine plants are classifiable with regard to the zones of climate; some being fitted for the torrid zone, some for the temperate, some for the frigid. And he establishes that the fuci of these early rocks speak of a torrid climate, although they may be found in what are now temperate regions; he also states that those of the higher rocks betoken, as we ascend, a gradually diminishing temperature.

We thus early begin to find proofs of the general uniformity of organic life over the surface of the earth, at the time when each particular system of rocks was formed. Species identical with the remains in the Wenlock limestone occur in the corresponding class of rocks in the Eifel, and par-

tially in the Harz, Norway, Russia,* and Brittany. The situations of the remains in Russia are fifteen hundred miles from the Wenlock beds; but at the distance of between six and seven thousand from those,—namely, in the vale of Mississippi, the same species are discovered. Uniformity in animal life over large geographical areas argues uniformity in the conditions of animal life; and hence arise some curious inferences. Species, in the same low class of animals, are now much more limited; for instance, the Red Sea gives different polypiaria, zoophytes, and shell-fish, from the Mediterranean. It is the opinion of M. Brongniart, that the uniformity which existed in the primeval times can only be attributed to the temperature arising from the internal heat, which had yet, as he supposes, been sufficiently great to overpower the ordinary meteorological influences, and spread a tropical clime all over the globe.

* In Russia, Mr. Murchison has lately found fucoids in the Silurians below any point at which animal remains occur. "The fact," he says, "of the existence of marine vegetables alone in the lowest of those rocks, and their co-existence with the earliest traces of the remains of animals, sustains that law of the economy of nature, from which it might necessarily have been inferred that large classes of animals could not have existed without vegetable sustenance."

ERA OF THE OLD RED SANDSTONE—FISHES ABUNDANT.

We advance to a new chapter in this marvellous history—the era of the *Old Red Sandstone System.* This term has been recently applied to a series of strata, of enormous thickness in the whole mass, largely developed in Herefordshire, Shropshire, Worcestershire, and South Wales; also in the counties of Fife, Forfar, Moray, Cromarty, and Caithness; and in Russia and North America, if not in many other parts of the world. The particular strata forming the system are somewhat different in different countries; but there is a general character to the extent of these being a mixture of flagstones, marly rocks, and sandstones, usually of a laminous structure, with conglomerates. There is also a schist shewing the presence of bitumen; a remarkable new ingredient, since it is a vegetable production.

In the conglomerates, of great extent and thickness, which form, in at least one district, the basis or leading feature of the system, inclosing water-worn fragments of quartz and other rocks, we have evidence of the seas of that period having been subjected to a violent and long-continued agitation, probably from volcanic causes. The upper members of the series bear the appearance of having been deposited in comparatively tranquil seas. The English specimens of this system shew a remarkable freedom from those disturbances which result in the interjection of trap; and they are thus defective in mineral ores. In some parts of England the old red sandstone system has been stated as 10,000 feet in thickness.

In this era, the forms of life which existed in the Silurian are continued: we have the same orders of marine creatures, zoophyta, polypiaria, mollusca, crustacea; but to these are added numerous fishes, some of which are of most extraordinary and surprising forms. Several of the strata are crowded with remains of fish, shewing that the seas in which those beds were deposited had swarmed with that class of inhabitants. The investigation of this system is recent; but already M. Agassiz has ascertained about twenty genera

and thrice the number of species. And it is remarkable that the Silurian fishes are here only represented in genera; the whole of the *species* of that era had already passed away. Even throughout the sub-groups of the system itself, the species are changed; and these are phenomena observed throughout all the subsequent systems or geological eras; apparently arguing that, during the deposition of all the rocks, a gradual change of physical conditions was constantly going on. A varying temperature, or even a varying depth of sea, would at present be attended with similar changes in marine life; and by analogy we are entitled to assume that such variations in the ancient seas might be amongst the causes of that constant change of genera and species in the inhabitants of those seas to which the organic contents of the rocks bear witness.

The predominating fishes of this system, and the only ones which (as far as fossils shew) existed for some ages, are arranged by M. Agassiz in two orders, with a regard to their external covering, which that naturalist holds to be, in fishes, a reflection of the internal organization. Both, it is to be remarked at the very first, are manifestly of an inferior character to the two other orders which

afterwards came into existence, and still are the principal fishes of our seas, these being covered by true scales, and respectively named ctenoid and cycloid, from the forms of that part of their organization. The two orders of early fish are covered with integuments considerably different in character; the one (*placoids*) with irregular enamelled plates, the other (*ganoids*) with regular enamelled scales, the first being not placed over each other, as scales are, but laid edge to edge, in the manner of a pavement. These characters, according to M. Agassiz, were accompanied by a rudimentary or cartilaginous skeleton, while the ctenoids and cycloids possess an osseous structure.

Of certain of the ganoids, it is remarked by every geologist, how much they approximate to the form and armature of the crustaceans, an order of the next lower department of the animal kingdom.

The *cephalaspis* may be considered as making the smallest advance from the crustacean character; it very much resembles in form the asaphus of lower formations, having a longish tail-like body inserted within the cusp of a large crescent-shaped head, somewhat like a saddler's cutting-knife. The body is covered with strong plates of bone, ena-

melled, and the head was protected on the upper side with one large plate, as with a buckler—hence the name, implying *buckler-head.* A range of small fins conveys the idea of its having been as weak in motion as it is strong in structure. The *coccosteus* may be said to mark the next advance to the perfect fish type. The outline of its body is of the form of a short thick coffin, rounded, covered with strong bony plates, and terminating in a long tail, which seems to have been the sole organ of motion. While the tail establishes this creature among the vertebrata and the fishes, its teeth, chiselled, as it were, out of the solid bone of the jaw, like the nippers of a lobster, and its mouth opening vertically, contrary to the usual mode of the vertebrata, enforce our placing it near the crustaceans. The *pterichthys* has also strong bony plates over its body, arranged much like those of a tortoise, and has a long tail; but its most remarkable feature, and that which has suggested its name, is a pair of long and narrow wing-like appendages attached to the shoulders, which the creature is supposed to have erected for its defence when attacked by an enemy.

The *holoptychius* is of a flat oval form, furnished with fins, and ending in a long tail; the whole

body covered with strong plates which overlap each other, and the head forming only a slight rounded projection from the general figure. The specimens in the lower beds are not above the size of a flounder; but in the higher strata, to judge by the size of the scales or plates which have been found, the creature attained a comparatively monstrous size.*

The placoids are now slenderly represented by the shark, cestraceon, &c., of modern seas; the ganoids are all but unrepresented in our time. Of both classes, one invariable peculiarity has attracted much attention. "In all recent fish, with the exception of the shark family, the sturgeon, and the long pike, the vertebral column terminates at the point where the caudal fin is given off, and this fin is expanded above and below the body, forming what is called a *homocercal* tail. In all those, without exception, which have been found in strata of the Palæozoic period, [placoids and ganoids,] the caudal fin is *heterocercal*, being

* The head fountain of information on the early fishes is M. Agassiz's Fossil Ichthyology, a splendid but not readily accessible book. For more popular descriptions, reference may be made to "New Walks in an Old Field, by Hugh Miller," Edin., 1842, and to Jameson's Journal, July and October, 1844.

formed of two unequal branches, the upper one expanded immediately from the vertebral column, while the lower one is given off at a point some distance from the extremity."* Now it is a remarkable fact, that this one-sided tail is a peculiarity in the more perfect fishes (as the salmon) at a certain stage in their embryonic history; as is also the inferior position of the mouth, peculiar to the early fishes. More than this—in the earlier periods of embryonic life, there is no vertebral column. This organ is represented in embryos by a gelatinous cord, called the dorsal cord, which in maturity disappears as the vertebræ are formed upon it. M. Agassiz has satisfied himself that this was the nature of the organization of the early fishes, as it is that of the sturgeon of the present seas. It is not premature to remark how broadly these facts seem to hint at a parity of law affecting the progress of general creation, and the progress of an individual fœtus of one of the more perfect animals.†

* Ansted's Geology, i. 185.

† It is remarkable that, while the non-osseous fishes reach lower down in these points of organization than other orders, they rise higher in some points of development, and some of them even make an advance to the viviparous mode of reproduction. But it is well known that no family of animals is equally high in

It is equally ascertained of the types of being prevalent in the old red, as of those of the preceding system, that they are uniform in the corresponding strata of distant parts of the earth; for instance, Russia and North America.

In the old red sandstone, the marine plants, of which faint traces are observable in the Silurians, continue to appear. It would seem as if less change took place in the vegetation than in the animals of those early seas; and for this, as Mr. Miller has remarked, it is easy to imagine reasons. For example, an infusion of lime into the sea would destroy animal life, but be favourable to vegetation. It has also been surmised by M. Agassiz, from an examination of the fishes of the ancient seas, that the ocean did not at first contain much salt, but gradually acquired its present infusion of that material; a theory, it may be remarked,

all points of structure and endowment, and that many forms generally humble have characteristics of a comparatively elevated kind. There are features of even the human organization that would place our race below some of the inferior animals, if these were to be made an exclusive criterion. In using as a standard the series of peculiarities presented in the embryotic progress of an individual of a different order, and thus assigning the non-osseous fishes a low place, M. Agassiz seems to me to be acting upon principles to which every day is adding strength and authority.

which derives support from a recent suggestion, that the salt of the sea has been mainly brought thither, in the course of time, by rivers, these washing it in particles out of the land in common with other detritus, while it is obvious that rain does not restore it.* It is easy to suppose a comparative absence of salt in the early ocean affecting animal and vegetable marine life in different ways and degrees.

As yet there were no land animals or plants, and for this the presumable reason is, that no dry land as yet existed. We are not left to make this inference solely from the absence of land animals and plants; in the arrangement of the primary (stratified) rocks, we have further evidence of it. That these rocks were formed in a generally horizontal position, we are as well assured as that they were formed at the bottom of seas. But they are always found greatly inclined in position, tilted up against the slopes of the granitic masses which are beneath them in geological order, though often shooting up to a higher point in the atmosphere. No doubt can be entertained that these granitic masses, forming our principal mountain

* See Fownes's Actonian Prize Essay.

ranges, have been protruded from below, or, at least, thrust much further up, *since* the deposition of the primary rocks. The protrusion was what tilted up the primary rocks; and the inference is, of course, unavoidable, that these mountains have risen chiefly, at least, since the primary rocks were laid down. It is remarkable that, while the primary rocks thus incline towards granitic nuclei or axes, the strata higher in the series rest against these again, generally at a less inclination, or none at all, shewing that these strata were laid down after the swelling mountain eminences had, by their protrusion, tilted up the primary strata. And thus it may be said an era of local upthrowing of the primitive and (perhaps) central matter of our planet, is established as happening about the close of the primary strata, and beginning of the next ensuing system. It may be called the *Era of the Oldest Mountains*, or, more boldly, of the formation of the detached portions of dry land over the hitherto watery surface of the globe—an important part of the designs of Providence, for which the time was now apparently come. It may be remarked, that volcanic disturbances and protrusions of trap took place throughout the whole period of the deposition of the primary rocks; but

they were upon a comparatively limited scale, and probably all took place under water. It was only now that the central granitic masses of the great mountain ranges were thrown up, carrying up with them broken edges of the primary strata; a process which seems to have had this difference from the other, that it was the effect of a more tremendous force exerted at a lower depth in the earth, and generally acting in lines pervading a considerable portion of the earth's surface. We shall by-and-by see that the protrusion of some of the mountain ranges was not completed, or did not stop, at that period. There is no part of geological science more clear than that which refers to the ages of mountains. It is as certain that the Grampian mountains of Scotland are older than the Alps and Apennines, as it is that civilization had visited Italy, and had enabled her to subdue the world, while Scotland was the residence of "roving barbarians." The Pyrenees, Carpathians, and other ranges of continental Europe, are all younger than the Grampians, or even the insignificant Mendip Hills of southern England. Stratification tells this tale as plainly as Livy tells the history of the Roman republic. It tells us—to use the words of Professor Phillips—that at the time when the

Grampians sent streams and detritus to straits where now the valleys of the Forth and Clyde meet, the greater part of Europe was a wide ocean.

The last three systems—called, in England, the Cumbrian, Silurian, and Devonian, and collectively the palæozoic rocks, from their containing the remains of the earliest inhabitants of the globe—are of vast thickness; in England, not much less than 30,000 feet, or nearly six miles.

SECONDARY ROCKS.

ERA OF THE CARBONIFEROUS FORMATION.

COMMENCEMENT OF LAND PLANTS.

We now enter upon a new great epoch in the history of our globe. There was now dry land. As a consequence of this fact, there was fresh water; for rain, instead of immediately returning to the sea, as formerly, was now gathered in channels of the earth, and became springs, rivers, and lakes. There was now a theatre for the existence of land plants and animals, and it remains to be inquired if these accordingly were produced.

The Secondary Rocks, in which our further researches are to be prosecuted, consist of a great and varied series, resting, generally unconformably, against flanks of the upturned primary rocks,

sometimes themselves considerably inclined, at others, forming extensive basin-like beds, nearly horizontal; in many places much broken up and shifted by disturbances from below. They have all been formed out of the materials of the older rocks, by virtue of the wearing power of air and water, which is still every day carrying down vast quantities of the elevated matter of the globe into the sea. But the separate strata are each much more distinct in the matter of its composition than might be expected. Some are siliceous or arenaceous, (sandstones,) composed mainly of fine grains from the quartz rocks—the most abundant of the primary strata. Others are argillaceous—clays, shales, &c., chiefly derived, probably, from the slate beds of the primary series. Others are calcareous, derived from the early limestone. As a general feature, they are softer and less crystalline than the primary rocks, as if they had endured less of both heat and pressure than the senior formation. There are beds (*coal*) formed solely of vegetable matter, and some others in which the main ingredient is particles of iron, (*the iron black band.*) The secondary rocks are quite as communicative with regard to their portion of the earth's history as the primitive were.

The first, or lowest, group of the secondary rocks is called the *Carboniferous Formation*, from the remarkable feature of its numerous interspersed beds of coal. It commences with the beds of the *mountain limestone*, which, in some situations, as in Derbyshire and Ireland, are of great thickness, being alternated with chert, (a siliceous sandstone,) sandstones, shales, and beds of coal, generally of the harder and less bituminous kind, (*anthracite*,) the whole being covered in some places by the millstone grit, a siliceous conglomerate composed of the detritus of the primary rocks. The mountain limestone, attaining in England to a depth of eight hundred yards, greatly exceeds in volume any of the primary limestone beds, and shows an enormous addition of power to the causes formerly suggested as having produced this substance. In fact, distinct remains of corals, crinoidea, and shells, are so abundant in it, as to compose three-fourths of the mass in some parts. Above the mountain limestone commence the more conspicuous *coal beds*, alternating with sandstones, shales, beds of limestone, and ironstone. Coal is altogether composed of the matter of a terrestrial vegetation, transmuted by putrefaction of a peculiar kind, beneath the surface of water and in the absence of

air. Some fresh-water shells have been found in it, but few of marine origin, and no remains of those zoophytes and crinoidea so abundant in the mountain limestone and other rocks. Coal beds exist in Europe, Asia, and America, and have hitherto been esteemed as the most valuable of mineral productions, from the important services which the substance renders in manufactures and in domestic economy. It is to be remarked, that there are some local variations in the arrangement of coal beds. In France, they rest immediately on the granite and other primary rocks, the intermediate strata not having been found at those places. In America, the kind called anthracite occurs among the slate beds, and this species also abounds more in the mountain limestone than with us. These last circumstances only shew that different parts of the earth's surface did not all witness the same events of a certain fixed series exactly at the same time. There had been an exhibition of dry land about the site of America, a little earlier than in Europe.

Some features of the condition of the earth during the deposition of the carboniferous group, are made out with a clearness which must satisfy most minds. First we are told of a time when

carbonate of lime was formed in vast abundance at the bottoms of profound seas, accompanied by an unusually large population of corals and encrinites; while in some parts of the earth there were patches of dry land, covered with a luxuriant vegetation. Next we have a comparatively brief period of volcanic disturbance, (when the conglomerate was formed.) Then the causes favourable to the so abundant production of limestone, and the large population of marine acrita, decline, and we find the masses of dry land increase in number and extent, and begin to bear an amount of forest vegetation, far exceeding that of the most sheltered tropical spots of the present surface. The climate, even in the latitude of Baffin's Bay, was torrid, and perhaps the atmosphere contained a larger charge of carbonic acid gas (the material of vegetation) than it now does. The forests or thickets of the period included no species of plants now known upon earth. They mainly consisted of gigantic shrubs, many of which are not represented by any existing types, while others are akin to kinds which, in temperate climes at least, are now only found in small and lowly forms. That these forests grew upon a Polynesia, or multitude of small islands, is considered probable, from similar

vegetation being now found in such situations within the tropics. With regard to the circumstances under which the masses of vegetable matter were transformed into successive coal strata, geologists are divided. From examples seen at the present day, at the mouths of such rivers as the Mississippi, which traverse extensive sylvan regions, and from other circumstances to be adverted to, it is held likely by some that the vegetable matter, the rubbish of decayed forests, was carried by rivers into estuaries, and there accumulated in vast natural rafts, until it sunk to the bottom, where an overlayer of sand or mud would prepare it for becoming a stratum of coal. Others conceive that the vegetation first went into the condition of a peat moss, that a sink in a level then exposed it to be overrun by the sea, and covered with a layer of sand or mud; that a subsequent uprise made the mud dry land, and fitted it to bear a new forest, which afterwards, like its predecessor, became a bed of peat; that, in short, by repetitions of this process, the alternate layers of coal, sandstone, and shale, constituting the carboniferous group, were formed. It is favourable to this last view that marine fossils are scarcely found in the body of the coal itself, though abun-

dant in the shale layers above and below it; also that in several places erect stems of trees are found with their roots still fixed in the shale beds, and crossing the sandstone beds at almost right angles, showing that these, at least, had not been drifted from their original situations. On the other hand, it is not easy to admit such repeated risings and sinkings of surface as would be required, on this hypothesis, to form a series of coal strata. Perhaps we may most safely rest at present with the supposition that coal has been formed under both classes of circumstances, though in the latter only as an exception to the former.

Upwards of three hundred species of plants have been ascertained to exist in the coal formation; but it is not necessary to suppose that the whole contained in that system are now, or ever will be distinguished. Experiments show that some great classes of plants become decomposed in water in a much less space of time than others, and it is remarkable that those which decompose soonest, are of the classes found most rarely, or not at all, in the coal strata. It is consequently to be inferred that there may have been grasses and mosses at this era, and many species of trees, the remains of which had lost all trace of organic form before their sub-

stance sunk into the mass of which coal was formed. In speaking, therefore, of the vegetation of this period, we must bear in mind that it may have comprehended forms of which we have no memorial.

Supposing, nevertheless, that, in the main, the ascertained vegetation of the coal system is that which grew at the time of its formation, it is interesting to find that the terrestrial botany of our globe begins with classes of comparatively simple forms and structure. In the ranks of the vegetable kingdom, the lowest place is taken by plants of cellular tissue, and which have no flowers, (*cryptogamia,*) as lichens, mosses, fungi, ferns, sea-weeds. Above these stand plants with vascular tissue, and bearing flowers, in which again there are two great subdivisions; first, plants having one seed-lobe, (*monocotyledons,*) and in which the new matter is added within, (*endogenous,*) of which the cane and palm are examples; second, plants having two seed-lobes, (*dicotyledons,*) and in which the new matter is added on the outside under the bark, (*exogenous,*) of which the pine, elm, oak, and all of the British forest-trees are examples; these subdivisions also ranking in the order in which they are here stated. Now it is clear that a pre-

dominance of these forms in succession marked the successive epochs developed by fossil geology; the simple abounding first, and the complex afterwards.

Two-thirds of the plants of the carboniferous era are of the cellular or cryptogamic kind, a proportion which would probably be much increased if we knew the whole Flora of that era. The ascertained dicotyledons, or higher-class plants, are comparatively few in this formation; but it will be found that they constantly increased as the globe grew older.

The master-form or type of the era was the *fern*, or breckan, of which about one hundred and thirty species have already been ascertained as entering into the composition of coal.* The ferns are plants which thrive best in warm, shaded, and moist situations. In tropical countries, where these conditions abound, there are many more species than in temperate climes, and some of these are arborescent, or of a tree-like size and luxuriance.† The ferns of the coal strata have been of this magnitude, and that without regard to

* The principal genera are named sphenopteris, neuropteris, and pecopteris.

† A specimen from Bengal, in the staircase of the British Museum, is forty-five feet high.

the parts of the earth where they are found. In the coal of Baffin's Bay, of Newcastle, and of the torrid zone, alike, are the fossil ferns arborescent, showing clearly that, in that era, the present tropical temperature, or one even higher, existed in very high latitudes.

In the swamps and ditches of England there grows a plant called the horse-tail, (*equisetum,*) having a succulent, erect, jointed stem, with slender leaves, and a scaly catkin at the top. A second large section of the plants of the carboniferous era were of this kind, (*equisetaceæ,*) but, like the fern, reaching the magnitudes of trees. While existing equiseta rarely exceed three feet in height, and the stems are generally under half an inch in diameter, their kindred, entombed in the coal beds, seem to have been generally fourteen or fifteen feet high, with stems from six inches to a foot in thickness. It is to be remarked that plants of this kind (forming two genera, the most abundant of which is the *calamites*) are only represented on the present surface by plants of the same *family:* the *species* which flourished at this era gradually lessen in number as we advance upwards in the series of rocks, and disappear before we arrive at the tertiary formation.

The club-moss family (*lycopodiaceæ*) are other plants of the present surface, usually seen in a lowly and creeping form in temperate latitudes, but presenting species which rise to a greater magnitude within the tropics. Many specimens of this family are found in the coal beds; it is thought they have contributed more to the substance of the coal than any other family. But, like the ferns and equisetaceæ, they rise to a prodigious magnitude. The lepidodendra (so the fossil genus is called) have probably been from sixty-five to eighty feet in height, having at their base a diameter of about three feet, while their leaves measured twenty inches in length. In the forests of the coal era, the lepidodendra would enjoy the rank of firs in our forests, affording shade to the only less stately ferns and calamites. The internal structure of the stem, and the character of the seed-vessels, show them to have been a link between single-lobed and double-lobed plants—a fact worthy of note, as it favours the idea that, in vegetable as well as animal creation, a progress has been observed, in conformity with advancing conditions. It is also curious to find a missing link of so much importance in a genus of plants which has long ceased to have a living place upon earth.

The other leading plants of the coal era are without representatives on the present surface, and their characters are in general less clearly ascertained. Amongst the most remarkable are—the *sigillaria*, of which large stems are very abundant, shewing that the interior has been soft, and the exterior fluted, with separate leaves inserted in vertical rows along the flutings—and the *stigmaria*, a plant apparently calculated to flourish in marshes, or pools, having a short, thick, fleshy stem, with a dome-shaped top, from which sprung branches of from twenty to thirty feet long. Amongst monocotyledons were some palms, (*flabellaria* and *nœggerathia*,) besides a few not distinctly assignable to any class.

The dicotyledons of the coal are comparatively few, though on the present surface they are the most numerous sub-class. Besides some of doubtful affinity, (*annularia*, *asterophyllites*, &c.,) there were a few of the pine family, which seem to have been the highest class of trees of this era, and are only as yet found in isolated cases, and in sandstone beds. The first discovered lay in the Craigleith quarry, near Edinburgh, and consisted of a stem about two feet thick, and forty-seven feet in length. Others have since been found, both in the

same situation, and at Newcastle. Leaves and fruit being wanting, an ingenious mode of detecting the nature of these trees was hit upon by some naturalists residing in the northern capital.* Taking thin polished cross slices of the stem, and subjecting them to the microscope, they detected the structure of the wood to be that of a cone-bearing tree, by the presence of certain "reticulations" which distinguish that family, in addition to the usual radiating and concentric lines. That particular tree was concluded to be an araucaria, a species now found in Norfolk Island, in the South Sea, and in a few other remote situations. The coniferæ of this era form the dawn of dicotyledonous trees, of which they may be said to be the simplest type, and to which, it has already been noticed, the lepidodendra are a link from the monocotyledons. The concentric rings of the Craiglcith and other coniferæ of this era have been mentioned. It is interesting to find in these a record of the changing seasons of those early ages, when as yet there were no human beings to observe time or tide. The rings are clearly traced; but it is observed that they are more slightly marked than is the case with

* See Witham, on the Internal Structure of Fossil Vegetables. 1834.

their family at the present day, as if the changes of temperature had been within a narrower range.

Such was the vegetation of the carbonigenous era, composed of forms at the bottom of the botanical scale, flowerless, fruitless, but luxuriant and abundant beyond what the most favoured spots on earth can now show. The rigidity of the leaves of its plants, and the absence of fleshy fruits and farinaceous seeds, unfitted it to afford nutriment to animals; and, monotonous in its forms, and destitute of brilliant colouring, its sward probably unenlivened by any of the smaller flowering herbs, its shades uncheered by the hum of insects, or the music of birds, it must have been a sombre scene to a human visitant. But neither man nor any other animals were then in existence to look for such uses or such beauties in this vegetation. It was serving other and equally important ends, clearing (probably) the atmosphere of matter noxious to animal life, and storing up mineral masses which were in long subsequent ages to prove of the greatest service to the human race, even to the extent of favouring the progress of its civilization.

The animal remains of this era are not numerous, in comparison with those which go before, or

those which come after. The mountain limestone, indeed, deposited at the commencement of it, abounds unusually in polypiaria and crinoidea; but when we ascend to the coal-beds themselves, the case is altered, and these marine remains altogether disappear. We have then only a limited variety of shell mollusks, with fragments of a few species of fishes, and these are rarely or never found in the coal seams, but in the shales alternating with them. At this time, the sauroids, a family of the ganoid fishes, are considered as at their apogee, or point of greatest abundance; a fact of some importance, seeing that, in teeth, bones, and scales, they make an advance to the lizard character, a type of a higher order of animals which we are soon to see entering upon the stage.* Of this link family is the Megalich-

* The sauroid fishes are often adduced as a proof that animals do not make their appearance in the series of rocks in the order of their comparative organization. But I do not see how they affect this question in such a manner. They are marked in the instructive chart of M. Agassiz (copied in Jameson's Journal, Oct. 1844) as commencing after the large family of Lepidoids, and as attaining their apogee considerably later. The subsequent rise of orders of fishes (ctenoids and cycloids) which do not so nearly approach the reptilian type, seems to me indifferent, as far as that question is concerned.

thys Hibbertti, found by Dr. Hibbert Ware, in a limestone bed of fresh-water origin, underneath the coal of Burdiehouse, near Edinburgh. Others of the same kind have been found in the coal-measures in Yorkshire, and in the low coal shales at Manchester.

Coal strata are nearly confined to the group termed the carboniferous formation. Thin beds are not unknown afterwards, but they occur only as a rare exception. It is therefore thought that the most important of the conditions which allowed of so abundant a terrestrial vegetation, had ceased about the time when this formation was closed. The high temperature was not one of the conditions which terminated, for there are evidences of it afterwards; but probably the superabundance of carbonic acid gas supposed to have existed during this era was expended before its close. There can be little doubt that the infusion of a large dose of this gas into the atmosphere at the present day would be attended by precisely the same circumstances as in the time of the carboniferous formation. Land animal life would not have a place on earth; vegetation would be enormous; and coal strata would be formed from the vast accumulations of woody matter, which would gather in

every sea, near the mouths of great rivers. On the exhaustion of the superabundance of carbonic acid gas, the coal formation would cease, and the earth might again become a suitable theatre of being for land animals.

The termination of the carboniferous formation is marked by symptoms of volcanic violence, which some geologists have considered to denote the close of one system of things and the beginning of another. Coal beds generally lie in basins, as if following the curve of the bottom of seas. But there is no such basin which is not broken up into pieces, some of which have been tossed up on edge, others allowed to sink, causing the ends of strata to be in some instances many yards, and in a few several hundred feet, removed from the corresponding ends of neighbouring fragments. These are held to be results of volcanic movements below, the operation of which is further seen in numerous upbursts and intrusions of fire-born rock, (trap.) That these disturbances took place about the close of the formation, and not later, is shewn in the fact of the next higher group of strata being comparatively undisturbed. Other symptoms of this time of violence are seen in the beds of conglomerate which occur amongst the first strata

above the coal. These, as usual, consist of fragments of the elder rocks, more or less worn from being tumbled about in agitated water, and laid down in a mud paste, afterwards hardened. Volcanic disturbances break up the rocks; the pieces are worn in seas; and a deposit of conglomerate is the consequence. Of porphyry, there are some such pieces in the conglomerate of Devonshire, three or four tons in weight. It is to be admitted for strict truth that, in some parts of Europe, the carboniferous formation is followed by superior deposits, without the appearance of such disturbances between their respective periods; but apparently this case belongs to the class of exceptions already noticed. That disturbance was general, is supported by the further and important fact of the destruction of many forms of organic being previously flourishing, particularly of the vegetable kingdom.

ERA OF THE NEW RED SANDSTONE.

TERRESTRIAL ZOOLOGY COMMENCES WITH REPTILES.

FIRST TRACES OF BIRDS.

THE next volume of the rock series refers to an era distinguished by an event of no less importance than the commencement of land animals. The *New Red Sandstone System* is subdivided into groups, some of which are wanting in some places. The lowest beds are those alluded to in the preceding chapter as presenting indications of disturbance. Next occur the strata of the Magnesian Limestone, denoting from their composition a recurrence of circumstances favourable to animal life. Beds usually called the Upper New Red Sandstone, followed in Germany by the Muschelkalk, or Shell Limestone, are next in the series;

they are crowned by a group of Variegated Marls. This section of rocks forms, in whole, a sort of transitionary series, from the Carboniferous to the Oolitic; and, though peculiar in mineral constitution, might, as far as fossils are concerned, be very properly divided between the preceding and succeeding formations.

The plants of this era are few and unobtrusive. Equiseta, calamites, ferns, Voltzia, and a few of the other families, found so abundantly in the carboniferous series, here present themselves, but in diminished size and quantity.

The types of animal being which existed before —zoophytes, conchifers, mollusks, crustacea, and fishes—continue to appear in the New Red Sandstone Rocks, being most numerous in the limestone beds, but particularly in the German sub-group of the Muschelkalk. All of these great classes are aquatic. Hitherto, no animal capable of breathing the atmosphere has been presented to our observation. But now, in this New Red formation, we discover the remains and other appearances of a group of animals of higher character, and adapted for living in another element—namely, reptiles. These are the forms considered as next to fishes in the zoological scale. So near are they to fishes,

that certain species stand doubtfully between the two classes, having extremities which can hardly be distinguished from fins. Many reptiles are also amphibious in their habits, or adapted for living partly in water and partly on land. The surface of the globe in the era of the New Red Sandstone appears to have abounded in large flat muddy shores, such as would form a proper field of existence for reptiles, and accordingly we see that class of animals called into existence.

It has also been suggested that the atmosphere of that age was of a kind which only admitted of reptile life. The immediate effects of the slow respiration of the reptilia are a low temperature in their bodies, and a small consumption of food. Requiring little oxygen, they could have existed in an atmosphere containing a less proportion of that gas to carbonic acid than now exists—an atmosphere, in short, only somewhat improved from that attributed to the carbonigenous era, but not yet fit for land mammifers.

Amongst the reptilian vestiges of the age, we are first called upon to notice certain remains, out of which Professor Owen has constituted a genus called Labirinthidon, from the peculiar character of their teeth—animals in their main features batra-

chian; that is, allied to the order of which the frog and toad are conspicuous representatives, but all of them exceeding these animals in bulk, some being several feet in length: huge newts we may figure them to have been, walking about the muddy shores of the new-forming land.

Other reptiles there were—nothosaurus and rhynchosaurus—of lacertian or lizard-like character; the former indicating, in the fine sculpture of the cranium, and the large comparative size of the extremities, an approach to the crocodilian form, while the latter show some points of affinity to the birds. There were also tortoises, some of which reached a great size.

But fossils do not form the sole memorials of the extraordinary fauna of this age. Literal vestiges or foot-marks have come into notice, as betraying the character of various animals which then lived.

So low as the bottom of the carboniferous system, slabs are found marked over a great extent of surface with that peculiar corrugation or wrinkling which the receding tide leaves upon a sandy beach when the sea is but slightly agitated; and not only are these ripple-marks, as they are called, found on the surfaces, but casts of them are found on the under sides of slabs lying above. The

phenomena suggest the time when the sand ultimately formed into these stone slabs, was part of the beach of a sea of the carbonigenous era; when, left wavy by one tide, it was covered over with a thin layer of fresh sand by the next, and so on, precisely as such circumstances might be expected to take place at the present day. Sandstone surfaces, ripple-marked, are found throughout the subsequent formations: in those of the new red, at more than one place in England, they further bear impressions of rain-drops which have fallen upon them—the rain, of course, of the inconceivably remote age in which the sandstones were formed. In the Greensill sandstone, near Shrewsbury, it has even been possible to tell from what direction the shower came which impressed the sandy surface, the rims of the marks being somewhat raised on one side, exactly as might be expected from a slanting shower falling at this day upon one of our beaches. These facts have the same sort of interest as the season rings of the Craigleith conifers, speaking of a parity between some of the familiar processes of nature in those early ages and our own.

The animal vestiges which have been spoken of, form a singular, yet most faithful historical monu-

ment. In a quarry of this formation, at Corncockle Muir, in Dumfriesshire, where the slabs incline at an angle of thirty-eight degrees, the foot-marks of an animal supposed to have been a tortoise are distinctly traced up and down the slope, as if the creature had had occasion to pass backwards and forwards in that direction only, possibly in its daily visits to the sea. Some slabs similarly impressed, in the Stourton quarries in Cheshire, are further marked with a shower of rain which we know must have fallen *afterwards*, for its little hollows are impressed in the footmarks also, though more slightly than on the rest of the surface, the comparative hardness of a trodden place having apparently prevented so deep an impression being made. At Hessberg, in Saxony, the vestiges of four distinct animals have been traced, one of them a web-footed animal of small size, considered as a congener of the crocodile; another, whose footsteps having a resemblance to an impression of a swelled human hand, has caused it to be named the *cheirotherium*. The footsteps of the cheirotherium have been found also in the Stourton quarries above mentioned. Mr. Owen, who stands at the head of comparative anatomy in the present day, has expressed his belief that this

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last animal was the same batrachian (Labyrinthidon) of which he has found fragments in the new red sandstone of Warwickshire.

If geologists shall ultimately give their approbation to the inferences made from a recent discovery in America, we shall have the addition of perfect birds, though probably of a low type, to the animal forms of this era. It is stated to be in quarries of this rock, in the valley of Connecticut, that footprints have been found, apparently produced by birds of the order grallæ, or waders. "The footsteps appear in regular succession on the continuous track of an animal, in the act of walking or running, with the right and left foot always in their relative places. The distance of the intervals between each footstep on the same track is occasionally varied, but to no greater amount than may be explained by the bird having altered its pace. Many tracks of different individuals and different species are often found crossing each other, and crowded, like impressions of feet upon the shores of a muddy stream, where ducks and geese resort."* Some of these prints indicate small animals, but others denote birds of what would now be an un-

* Dr. Buckland, quoting an article by Professor Hitchcock, in the American Journal of Science and Arts, 1836.

usually large size. One animal, having a foot fifteen inches in length, (one-half more than that of the ostrich,) and a stride of from four to six feet, has been appropriately entitled, *ornithichnites giganteus.*

ERA OF THE OOLITE.

COMMENCEMENT OF MAMMALIA.

THE chronicles of this period consist of a series of beds, mostly calcareous, taking their general name (*Oolite System*) from a conspicuous member of them—the oolite—a limestone composed of an aggregation of small round grains or spherules, and so called from its fancied resemblance to a cluster of eggs, or the roe of a fish. This texture of stone is novel and striking. It is supposed to be of chemical origin, each spherule being an aggregation of particles round a central nucleus. The oolite system is largely developed in England, France, Westphalia, and Northern Italy; it appears in Northern India and Africa, and patches of it exist in Scotland, and in the vale of the Mississippi. It

may of course be yet discovered in many other parts of the world.

The series, as shewn in the neighbourhood of Bath, is (beginning with the lowest) as follows:— 1. Lias,..a set of strata variously composed of limestone, clay, marl, and shale, clay being predominant; 2. Lower oolitic formation, including, besides the great oolite bed of central England, fullers' earth beds, forest marble, and cornbrash; 3. Middle oolitic formation, composed of two subgroups, the Oxford clay and coral rag, the latter being a mere layer of the works of the coral polype; 4. Upper oolitic formation, including what are called Kimmeridge clay and Portland oolite. In Yorkshire there is an additional group above the lias, and in Sutherlandshire there is another group above that again. In the wealds (moorlands) of Kent and Sussex, there is, in like manner, above the fourth of the Bath series, another additional group, to which the name of the *Wealden* has been given, from its topographical situation, and which, composed of sandstones and clays, is subdivided into Purbeck beds, Hastings sand, and Weald clay.

There are no particular appearances of disturbance between the close of the new red sandstone

and the beginning of the oolite system, as far as has been observed in England. Yet there is a great change in the materials of the rocks of the two formations, shewing that, while the bottoms of the seas of the one period had been chiefly arenaceous, those of the other were chiefly clayey and limy. And there is an equal difference between the two periods in respect of both botany and zoology. While the new red sandstone shews comparatively scanty traces of organic creation, those in the oolite are extremely abundant, particularly in the department of animals, and more particularly still of sea mollusca, which, it has been observed, are always the more conspicuous in proportion to the predominance of calcareous rocks. It is also remarkable that the animals of the oolitic system are entirely different in species from those of the preceding age, and that these species cease before the next. In this system we likewise find that uniformity over great space which has been remarked of the Faunas of earlier formations. "In the equivalent deposits in the Himalaya Mountains, at Fernando Po, in the region north of the Cape of Good Hope, and in the Run of Cutch, and other parts of Hindostan, fossils have been discovered, which, as far as En-

glish naturalists who have seen them can determine, are undistinguishable from certain oolite and lias fossils of Europe."*

The dry land of this age presented cycadeæ, "a beautiful class of plants between the palms and conifers, having a tall, straight trunk, terminating in a magnificent crown of foliage."† There were tree ferns, but in smaller proportion than in former ages; also equisetaceæ, lilia, and coniferæ. The vegetation was generally analogous to that of the Cape of Good Hope and Australia, which seems to argue a climate (we must remember, a universal climate) between the tropical and temperate. It was, however, sufficiently luxuriant in some instances to produce thin seams of coal, for such are found in the oolite formation of both Yorkshire and Sutherland. The sea, as for ages before, contained algæ, of which, however, only a few species have been preserved to our day. The lower classes of the inhabitants of the ocean were unprecedentedly abundant. The polypiaria were in such abundance as to form whole strata of themselves. The crinoidea and echinites were also extremely numerous. Shell mollusks, in hundreds of new species, oc-

* Murchison's Silurian System, p. 583.

† Buckland.

cupied the bottoms of the seas of those ages, while of the swimming shell-fish, ammonites and belemnites, there were also many scores of varieties. The belemnite here calls for some particular notice. It commences in the oolite, and terminates in the next formation. It is an elongated, conical shell, terminating in a point, and having, at the larger end, a cavity for the residence of the animal, with a series of air-chambers below. The animal, placed in the upper cavity, could raise or depress itself in the water at pleasure by a pneumatic operation upon the air tube pervading its shell. Its tentacula, sent abroad over the summit of the shell, searched the sea for prey. The creature had an ink-bag, with which it could muddle the water around it, to protect itself from more powerful animals, and, strange to say, this has been found so well preserved that an artist has used it in one instance as a pigment, wherewith to delineate the belemnite itself.

The crustacea discovered in this formation are less numerous. There are many fishes, some of which (*acrodus, psammodus,* &c.) are presumed from remains of their palatal bones, to have been of the gigantic cartilaginous class (*placoidean,*) now represented by such as the cestraceon. It has been

considered by Professor Owen as worthy of notice, that, the cestraceon being an inhabitant of the Australian seas, we have, in both the botany and ichthyology of this period, an analogy to that continent. The pycnodontes, (thick-toothed,) and lepidoides, (having thick scales,) are other families described by M. Agassiz as extensively prevalent.

To the reptiles of the preceding age, some remarkable new forms are added in the Lias, combining peculiarities of structure of an extraordinary kind, and presenting general forms and habits which all geologists have felt to be somewhat marvellous.

The animal to which the name *ichthyosaurus* has been given, was as long as a young whale, and it was fitted for living in the water, though breathing the atmosphere. It had the vertebral column and general bodily form of a fish, but to that were added the head and breast-bone of a lizard, and the paddles of the whale tribes. The teeth were those of a crocodile. It must have been a most destructive creature to the fish of those early seas.

The *plesiosaurus* was of similar bulk, with a turtle-like body and paddles, shewing that the sea was its element, but with a long serpent-like neck, terminating in a saurian head, calculated to reach

prey at a considerable distance. These two animals, of which many varieties have been discovered, constituting distinct species, are supposed to have lived in the shallow borders of the seas of this and subsequent formations, devouring immense quantities of the finny tribes. It was at first thought that no creatures approaching them in character now inhabit the earth; but latterly Mr. Darwin has discovered, in the reptile-peopled Galapagos Islands, in the South Sea, a marine saurian from three to four feet long.

In the proper oolite some remarkable additions are made to the lias saurians. One named the *Pliosaurus*, resembling the Plesiosaurus, could not have been of less bulk than the largest of existing whales. There were many huge crocodilians, one of which, the *Cetiosaurus*, presents in its vertebræ, an approximation to the cetacean character. The *Megalosaurus* was an enormous carnivorous lizard, and Mr. Owen forms a genus of equally large crocodile-lizards, to which he gives the name of *Dinosauria*, and in the extremities of which we see a slight resemblance to the pachydermatous quadrupeds. Perhaps, however, the most curious form of being, belonging to what has not inaptly been called the Age of Reptiles, was the *Pterodactyle*,

a lizard of about the size of a snipe, provided with bat-like wings extended on the forefinger, wherewith to pursue its prey in the air.

Now, for the first time, we find remains of insects, an order of animals not well calculated for fossil preservation, and which are therefore amongst the rarest of the animal tribes found in rocks,* though they are the most numerous of all living families. A single libellula (dragon-fly) was found in the Stonesfield slate, a member of the lower oolitic group quarried near Oxford; and this was for several years the only specimen known to exist so early; but now many species have been found in a corresponding rock at Solenhofen, in Germany. It is remarkable that the remains of insects are found most plentifully near the remains of pterodactyles, to which they are presumed to have served as prey.

The first glimpse of the highest class of the vertebrate sub-kingdom—*mammalia*—is obtained from the Stonesfield slate, where there have been found several specimens of the lower jaw-bone of a

* It is extremely likely that insects lived before the reptilia, some families of which require them for food; and, in point of fact, remains of this great class are now said to be found in the carboniferous rocks.

quadruped evidently insectivorous, and inferred, from peculiarities of structure, to have belonged to the marsupial family, (pouched animals.)* It may be observed, although no specimens of so high a class of animals as mammalia are found earlier, such may nevertheless have existed: the defect may be in our not having found them; but other things considered, the probability is that heretofore there were no mammifers. It is an interesting circumstance that the first mammifers found should have belonged to the marsupialia, when the place of that order in the scale of creation is considered. In the imperfect structure of their brain, deficient in the organs connecting the two hemispheres—and in the mode of gestation, which is only in small part uterine—this family is clearly a link between the oviparous vertebrata (birds, reptiles, and fishes) and the higher mammifers. This is further established by their possessing a faint development of two canals passing from near the anus to the external surface of the viscera, which are fully possessed in reptiles and fishes, for the purpose of supplying aerated water

* Fragments attributed to a cetaceous animal, another humble form of the mammal class, have likewise been found in the great oolite, near Oxford.

to the blood circulating in particular vessels, but which are unneeded by mammifers. Such rudiments of organs in certain species which do not require them in any degree, are common in both the animal and vegetable kingdoms, but are always most conspicuous in families approaching in character to those classes to which the full organs are proper. This subject will be more particularly adverted to in the sequel.

The highest part of the oolitic formation presents some phenomena of an unusual and interesting character, which demand special notice. Immediately above the upper oolitic group in Buckinghamshire, in the vicinity of Weymouth, and other situations, there is a thin stratum, usually called by workmen the *dirt-bed*, which appears, from incontestable evidence, to have been a soil, formed, like soils of the present day, in the course of time, upon a surface which had previously been the bottom of the sea. The dirt-bed contains exuviæ of tropical trees, accumulated through time, as the forest shed its honours on the spot where it grew, and became itself decayed. Near Weymouth there is a piece of this stratum, in which stumps of trees remain rooted, mostly erect or slightly inclined, and from one to three feet high; while

trunks of the same forest, also silicified, lie imbedded on the surface of the soil in which they grew.

Above this bed lie those which have been called the Wealden, from their full development in the Weald of Sussex; and these as incontestably argue that the dry land forming the dirt-bed had next afterwards become the area of brackish estuaries, or lakes partially connected with the sea; for the Wealden strata contain exuviæ of fresh-water tribes, besides those of the great saurians and chelonia. The area of this estuary comprehends the whole south-east province of England. A geologist thus confidently narrates the subsequent events: "Much calcareous matter was first deposited [in this estuary], and in it were entombed myriads of shells, apparently analogous to those of the vivipara. Then came a thick envelope of sand, sometimes interstratified with mud; and, finally, muddy matter prevailed. The solid surface beneath the waters would appear to have suffered a long continued and gradual depression, which was as gradually filled, or nearly so, with transported matter; in the end, however, after a depression of several hundred feet, the sea again entered upon the area, not suddenly or violently—for the Wealden rocks pass gradually into the superincumbent cretaceous

series—but so quietly, that the mud containing the remains of terrestrial and fresh-water creatures was tranquilly covered up by sands replete with marine exuviæ."* A subsequent depression of the same area, to the depth of at least three hundred fathoms, is believed to have taken place, to admit of the deposition of the cretaceous beds lying above.

From the scattered way in which remains of the larger terrestrial animals occur in the Wealden, and the intermixture of pebbles of the special appearance of those worn in rivers, it is also inferred that the estuary which once covered the south-east part of England was the mouth of a river of that far-descending class of which the Mississippi and Amazon are examples. What part of the earth's surface presented the dry land through which that and other similar rivers flowed, no one can tell. It has been surmised, that the particular one here spoken of may have flowed from a point not nearer than the site of the present Newfoundland. Professor Phillips has suggested, from the analogy of the mineral composition, that anciently elevated coal strata may have composed the dry land from which the sandy matters of these strata

* De la Beche's Geological Researches, p. 344.

were washed. Such a deposit as the Wealden almost necessarily implies a local, not a general condition; yet it has been thought that similar strata and remains exist in the Pays de Bray, near Beauvais. This leads to the supposition that there may have been, in that age, a series of river-receiving estuaries along the border of some such great ocean as the Atlantic, of which that of modern Sussex is only an example.

ERA OF THE CRETACEOUS FORMATION.

THE record of this period consists of a series of strata, in which chalk beds make a conspicuous appearance, and which is therefore called the cretaceous system or formation. In England, a long stripe, extending from Yorkshire to Kent, presents the cretaceous beds upon the surface, generally lying conformably upon the oolite, and in many instances rising into bold escarpments towards the west. The celebrated cliffs of Dover are of this formation. It extends into northern France, and thence north-westward into Germany, whence it is traced into Scandinavia and Russia. The same system exists in North America, and probably in other parts of the earth not yet geologically investigated. Being a marine deposit, it establishes that seas existed at the time of its formation on

the tracts occupied by it, while some of its organic remains prove that, in the neighbourhood of those seas, there were tracts of dry land.

The cretaceous formation in England presents beds chiefly sandy in the lowest part, chiefly clayey in the middle, and chiefly of chalk in the upper part, the chalk beds being never absent, which some of the lower are in several places. In the vale of the Mississippi, again, the true chalk is wholly, or all but wholly absent. In the south of England, the lower beds are, (reckoning from the lowest upwards), 1. *Shankland* or *greensand*, "a triple alternation of sands and sandstones with clay;" 2. *Galt*, "a stiff blue or black clay, abounding in shells, which frequently possess a pearly lustre;" 3. *Hard* chalk; 4. Chalk with flints; these two last being generally white, but in some districts red, and in others yellow. The whole are, in England, about 1200 feet thick, shewing the considerable depths of the ocean in which the deposits were made.

Chalk is a carbonate of lime, and the manner of its production in such vast quantities was long a subject of speculation among geologists. Some light seemed to be thrown upon the subject a few years ago, when it was observed, that the detritus

of coral reefs in the present tropical seas gave a powder, undistinguishable, when dried, from ordinary chalk. It then appeared likely that the chalk beds were the detritus of the corals which were in the oceans of that era. Mr. Darwin, who made some curious inquiries on this point, further suggested, that the matter might have intermediately passed through the bodies of worms and fish, such as feed on the corals of the present day, and in whose stomachs he has found impure chalk. This, however, cannot be a full explanation of the production of chalk, if we admit some more recent discoveries of Professor Ehrenberg. That master of microscopic investigation announces, that chalk is composed partly of "inorganic particles of irregular elliptical structure and granular slaty disposition," and partly of shells of inconceivable minuteness, "varying from the one-twelfth to the two hundred and eighty-eighth part of a line"—a cubic inch of the substance containing above ten millions of them! The chalk of the north of Europe contains, he says, a large proportion of the inorganic matter; that of the south, a larger proportion of the organic matter, being in some instances almost entirely composed of it. He has been able to classify many of these creatures, some of them being allied

to the nautili, nummuli, cyprides, &c. The shells of some are calcareous, of others siliceous. M. Ehrenberg has likewise detected microscopic sea-plants in the chalk.

The distinctive feature of the uppermost chalk beds in England is the presence of flint nodules. These are generally disposed in layers parallel to each other. It was readily presumed by geologists that these masses were formed by a chemical aggregation of particles of silica, originally held in solution in the mass of the chalk. But whence the silica in a substance so different from it? Ehrenberg suggests that it is composed of the siliceous coverings of a portion of the microscopic creatures, whose shells he has in other instances detected in their original condition. It is remarkable that the chalk *with* flint abounds in the north of Europe; that *without* flints in the south; while in the northern chalk siliceous animalcules are wanting, and in the southern present in great quantities. The conclusion seems hardly avoidable, that in the one case the siliceous exuviæ have been left in their original form; in the other dissolved chemically, and aggregated on the common principle of chemical affinity into nodules of flint, probably concentrating, in every instance, upon a piece of decaying

organic matter, as has been the case with the nodules of ironstone in the earlier rocks, and the spherules of the oolite.

What is more remarkable, M. Ehrenberg has ascertained that at least fifty-seven species of the microscopic animals of the chalk, being infusoria and calcareous-shelled polythalamia, are still found living in various parts of the earth. These species are the most abundant in the rock. Singly they are the most unimportant of all animals, but in the mass, forming as they do such enormous strata over a large part of the earth's surface, they have an importance greatly exceeding that of the largest and noblest of the beasts of the field. Moreover, these species have a peculiar interest, as the only specific types of that early age which are reproduced in the present day. Species of sea mollusks, of reptiles, and of mammifers, have been changed again and again, since the cretaceous era; and it is not till a long subsequent age that we find the first traces of any other of even the humblest species which now exist; but here have these humble infusoria and polythalamia kept their place on earth through all its revolutions since that time, —are we to say, safe in their very humility, which might adapt them to a greater variety of circum-

stances than most other animals, or are we required to look for some other explanation of the phenomenon?

All the ordinary and more observable orders of the inhabitants of the sea, except the cetacea, have been found in the cretaceous formation—zoophytes, radiaria, mollusks, crustacea, (in great variety of species,) and fishes in smaller variety. Down to this period, the placoid and ganoid fishes had, as far as we have evidence, flourished alone; now they decline, and we begin to find in their place fishes of two orders of superior organization, the orders which predominate in the present creation. These are osseous in internal structure, with corneous scales, the latter being circular in the one case, and pectinated or indented at one side in the other; hence the two orders are called respectively cycloid and ctenoid by M. Agassiz, who, as has been remarked, asserts that the outer covering of fishes is a sufficient indication of their whole structure. In Europe, no remains of the marine saurians have been found; they may be presumed to have become extinct in that part of the globe before this time.

In America, however, remains of the plesiosaurus have been discovered in this part of the stratified

series. The reptiles, too, so numerous in the two preceding periods, appear to have now much diminished in numbers. One of the most remarkable was the mosæsaurus, which seems to have held an intermediate place between the monitor and iguana, and to have been about twenty-five feet long, with a tail calculated to assist it powerfully in swimming.

Fuci abounded in the seas of this era, and confervæ are found enclosed in flints. Of terrestrial vegetation, as of terrestrial animals, the specimens in the European area are comparatively rare, rendering it probable that there was no dry land near. The remains are chiefly of ferns, conifers, and cycadeæ, but in the two former cases we have only cones and leaves. There have been discovered many pieces of wood, containing holes drilled by the teredo, and thus shewing that they had been long drifted about in the ocean before being entombed at the bottom.

The series in America corresponding to this, entitled the Ferruginous Sand formation, presents fossils generally identical with those of Europe, not excepting the fragments of drilled wood; shewing that, in this, as in earlier ages, there was a parity of conditions for animal life over a vast tract of the earth's surface. To European reptiles,

the American formation adds a gigantic one, styled the saurodon, from the lizard-like character of its teeth.

We have seen that footsteps of birds are discovered in America, in the new red sandstone. Some similar isolated phenomena occur in the subsequent formations. Dr. Mantell found some bones of birds, apparently waders, in the Wealden. The immediate connexion of that set of beds with land, may account, of course, for their containing a terrestrial organic relic, which the marine beds above and below did not possess. In the slate of Glaris, in Switzerland, corresponding to the English galt, in the chalk formation, the remains of a bird have been found. From a chalk bed near Maidstone, have likewise been extracted some remains of a bird, supposed to have been of the long-winged swimmer family, and equal in size to the albatross. These, it must be owned, are less strong traces of the birds than we possess of the reptiles and other tribes; but it must be remembered, that the evidence of fossils, as to the absence of any class of animals from a certain period of the earth's history, is only negative. Animals, of which we find no remains in a particular formation, may, nevertheless, have lived at the time, and it may have

only been from unfavourable circumstances that their remains have not been preserved for our inspection. The single circumstance of their being little liable to be carried down into seas, might be the cause of their non-appearance in our quarries. There is at the same time a limit to uncertainty on this point. We see, from what remains have been found in the whole series, a clear progress throughout, from humble to superior types of being. Hence we derive a light as to what animals may have existed at particular times, which is in some measure independent of the specialities of fossilology. The birds are below the mammalia in the animal scale; and therefore they may be supposed to have existed about the time of the new red sandstone and oolite, although we find but slight traces of them in those formations, and, it may be said, till a considerably later period.

ERA OF THE TERTIARY FORMATION—MAMMALIA ABUNDANT.

THE chalk-beds are the highest which extend over a considerable space; but in hollows of these beds, comparatively limited in extent, there have been formed series of strata—clays, limestones, marls, alternating—to which the name of the *Tertiary Formation* has been applied. London and Paris alike rest on basins of this formation, and another such basin extends from near Winchester, under Southampton, and re-appears in the Isle of Wight. A stripe of it extends along the east coast of North America, from Massachusetts to Florida. It is also found in Sicily and Italy, insensibly blended with formations still in progress. Though comparatively a local formation, it is not of the less importance as a record of the condition of the

earth during a certain period. As in other formations, it is marked, in the most distant localities, by identity of organic remains.

The hollows filled by the tertiary formation must be considered as the beds of estuaries left at the conclusion of the cretaceous period. We have seen that an estuary, either by the drifting up of its mouth, or a change of level in that quarter, may be supposed to have become an inland sheet of water, and that, by another change, of the reverse kind, it may be supposed to have become an estuary again. Such changes the Paris basin appears to have undergone oftener than once, for, first, we have there a fresh-water formation of clay and limestone beds; then, a marine-limestone formation; next, a second fresh-water formation, in which the material of the celebrated *plaster of Paris* (gypsum) is included; then a second marine formation of sandy and limy beds; and finally, a third series of fresh-water strata. Such alternations occur in other examples of the tertiary formation likewise.

The tertiary beds present all but an entirely new set of animals, and as we ascend in the series, we find more and more of these identical with species still existing upon earth, as if we had now

reached the dawn of the present state of the zoology of our planet. By the study of the shells alone, Mr. Lyell has formed a division of the whole term into four sub-periods, to which he has given names with reference to the proportions which they respectively present of surviving species—first, eocene; second, miocene; third, older pliocene; fourth, newer pliocene. This division, however, is to be regarded as not safely applicable to the Tertiaries generally, except as a convenient means of indicating various portions of the series.

The eocene period presents, in three continental groups, 1238 species of shells, of which forty-two, or 3·5 per cent. yet flourish. Some of these are remarkable enough; but they all sink into insignificance beside the mammalian remains which the lower eocene deposits of the Paris basin present to us, shewing that the land had now become the theatre of an extensive creation of the highest class of animals. Cuvier ascertained about fifty species of these, all of them long since extinct. A considerable number are *pachydermata*,* of a character approximating to the South American

* Thick-skinned animals. This term has been given by Cuvier to an order in which the hog, elephant, horse, and rhinoceros are included.

tapir: the names palæotherium, anthracotherium, anoplotherium, lophiodon, &c., have been applied to them with a consideration of more or less conspicuous peculiarities; but a description of the first may give some general idea of the whole. It was about the size of a horse, but more squat and clumsy, and with a heavier head, and a lower jaw shorter than the upper; the feet, also, instead of hooves, presented three large toes, rounded, and unprovided with claws. These animals were all herbivorous. Amongst an immense number of others are found many new reptiles, some of them adapted for fresh water; species of birds allied to the sea-lark, curlew, quail, buzzard, owl, and pelican; species allied to the dormouse and squirrel; also the opossum and racoon; and species allied to the genette, fox, and wolf.

In the miocene sub-period, the shells give eighteen per cent. of existing species, shewing a considerable advance from the preceding era, with respect to the inhabitants of the sea. The advance in the land animals is less marked, but yet considerable. The predominating forms are still pachydermatous, and the tapir type continues to be conspicuous. One animal of this kind, called the *dinotherium*, is supposed to have been not less

than eighteen feet long; it had a mole-like form of the shoulder-blade, conferring the power of digging for food, and a couple of tusks turning down from the lower jaw, by which it could have attached itself, like the walrus, to a shore or bank, while its body floated in the water. Dr. Buckland considers this and some similar miocene animals, as adapted for a semi-aquatic life, in a region where lakes abounded. Besides the tapirs, we have in this era animals allied to the glutton, the bear, the dog, the horse, the hog, and lastly, several felinæ, (creatures of which the lion is the type;) all of which are new forms, as far as we know. There was also an abundance of marine mammalia, seals, dolphins, lamantins, walruses, and whales, none of which had previously appeared.

The shells of the older pliocene give from thirty-five to fifty; those of the newer, from ninety to ninety-five per cent. of existing species. The pachydermata of the preceding era now disappear, and are replaced by others belonging to still existing families—elephant, hippopotamus, rhinoceros, —though now extinct as species. Some of these are startling, from their enormous magnitude. The great mastodon, whose remains are found in

abundance in America, was a species of elephant, judged, from peculiarities of its teeth, to have lived on aquatic plants, and reaching the height of twelve feet. The mammoth was another elephant, but supposed to have survived till comparatively recent times, as a specimen, in all respects entire, was found in 1801, preserved in ice, in Siberia. We are more surprised by finding such gigantic proportions in an animal called the megatherium, which ranks in an order now assuming much humbler forms—the edentata—to which the sloth, ant-eater and armadillo belong. The megatherium had a skeleton of enormous solidity, with an armour-clad body, and five toes, terminating in huge claws, wherewith to grasp the branches, from which, like its existing congener, the sloth, it derived its food. The megalonyx was a similar animal, only somewhat less than the preceding. Finally, the pliocene gives us for the first time, oxen, deer, camels, and other specimens of the *ruminantia*.

Such is an outline of the fauna of the tertiary era, as ascertained by the naturalists who first devoted their attention to it. The exertions of these men were entitled to the highest praise; but their field of investigation was local, and even there they

left some important facts still to be gleaned. Amongst the latter is the discovery, in the eocene of the Isle of Sheppy, of the remains of a serpent (the first example of that reptilian order), and of a large quantity of fossil fruit. In strata supposed to be eocene at Kyson, near Woodbridge, the jaw-bone and tooth of a quadrumane were found in 1839. Another jaw-bone, containing several teeth, supposed to have belonged to a species of monkey about three feet high, was discovered about the same time in a stratum of marl surmounted by compact limestone, in the department of Gers, at the foot of the Pyrenees. Associated with this last were remains of not less than thirty mammiferous quadrupeds, including three species of rhinoceros, a large anoplotherium, three species of deer, two antelopes, a true dog, a large cat, an animal like a weazel, a small hare, and a huge species of the edentata. Both of these places are considerably to the north of any region now inhabited by the monkey tribes. Dr. Lund has also discovered, in the Tertiaries of Brazil, fossil remains of a quadrumane, belonging to the American group of that order. But the most remarkable discovery of this kind has been made amongst the tertiaries of the Sivalik Hills in Northern India, where, along with the

oldest genera of Pachydermata, we have remains of ruminants in abundance, and also a few of the ape tribes. The tendency of these and other investigations has been to shake geologists in their regard for Mr. Lyell's divisions of the tertiary formation, as far as the zoology of the subject is concerned, and to lead to a belief that this formation marks but one stage in the development of organic being, namely, that of Terrestrial Mammalia, exclusive of the human species.

One remarkable circumstance connected with the tertiary formation remains to be noticed,—the prevalence of volcanic action at that era. In Auvergne, in Catalonia, near Venice, and in the vicinity of Rome and Naples, lavas exactly resembling the produce of existing volcanoes, are associated and intermixed with the lacustrine as well as marine tertiaries. The superficies of tertiaries in England is disturbed by two great swells, forming what are called anticlinal axes, one of which divides the London from the Hampshire basin, while the other passes through the Isle of Wight, both throwing the strata down at a violent inclination towards the north, as if the subterranean disturbing force had *waved* forward in that direction. The Pyrenees, too, and Alps, have

both undergone elevation since the deposition of the tertiaries; and in Sicily there are mountains which have risen three thousand feet since the deposition of some of the most recent of these rocks. The general effect of these operations was of course to extend the land surface, and to increase the variety of its features, thus improving the natural drainage, and generally adapting the earth for the reception of higher classes of animals.

ERA OF THE SUPERFICIAL FORMATIONS.

COMMENCEMENT OF PRESENT SPECIES.

We have now completed our survey of the series of stratified rocks, and traced in their fossils the progress of organic creation down to a time which seems not long antecedent to the appearance of man. There are, nevertheless, memorials of still another era or space of time which it is all but certain did also precede that event.

The first that calls for notice is the phenomenon to which geologists have applied the term denudation. Great hitches and slips are detected in superficial strata,—such as, if left in their original state, must have caused considerable inequalities on the face of the country; yet all is found as smooth—the joinings are all as much reduced to a common level—as if some gigantic artificial force

had been used for the purpose. Again, a great valley has been scooped out in the midst of sedimentary strata, leaving the edges of these facing each other from the opposite sides, with perhaps here and there an isolated mass starting up to the height of the two sides, being composed of matter which has resisted the agency by which the adjoining matter was removed. There, it is thought, we see incontestible traces of the operation of moving water. The second fact we are called to notice is that, over the rock formations of all eras, in various parts of the globe, but confined in general to situations not very elevated, there is a layer of stiff clay, mostly of a blue colour, mingled with fragments of rock of all sizes, travel-worn, and otherwise, and to which geologists give the name of diluvium, as being apparently the produce of some vast flood, or of the sea thrown into an unusual agitation. It seems to indicate that, at the time when it was laid down, much of the present dry land was under the ocean, a supposition which we shall see supported by other evidence. The included masses of rock have been carefully inspected in many places, and traced to particular parent beds at considerable distances. Connected with these phenomena are certain rock surfaces on the

slopes of hills and elsewhere, which exhibit groovings and scratchings, such as we might suppose would be produced by a quantity of loose blocks hurried along over them by a flood. Another associated phenomenon is that called *crag and tail*, which exists in many places,—namely, a rocky mountain, or lesser elevation, presenting on one side the naked rock in a more or less abrupt form, and on the other a gentle slope; the sites of Windsor, Edinburgh, and Stirling, with their respective castles, are specimens of crag and tail. Finally, we may advert to certain long ridges of clay and gravel which arrest the attention of travellers on the surface of Sweden and Finland, and which are also found in the United States, where, indeed, the whole of these phenomena have been observed over a large surface, as well as in Europe. It is very remarkable that the direction from which the diluvial blocks have generally come, the lines of the grooved rock surfaces, the direction of the crag and tail eminences, and that of the clay and gravel ridges—phenomena, be it observed, extending over the northern parts of both Europe and America—*are all from the north and north-west towards the south-east.* We thus acquire the idea of a powerful current moving in a direction

from north-west to south-east, carrying, besides mud, masses of rock which furrowed the solid surfaces as they passed along, abrading the north-west faces of many hills, but leaving the slopes in the opposite direction uninjured, and in some instances forming long ridges of detritus along the surface. These are curious considerations, and it has become a question of much interest, by what means, and under what circumstances, was such a current produced. One hypothesis is not without some plausibility. From an investigation of the nature of glaciers, and some observations which seem to indicate that these have at one time extended to lower levels, and existed in regions (the Scottish Highlands an example) where there is now no perennial snow, it has been surmised that there was a time, subsequent to the tertiary era, when the circumpolar ice extended far into the temperate zone, and formed a lofty, as well as extensive accumulation. A change to a higher temperature, producing a sudden thaw of this mass, might set free such a quantity of water as would form a large flood, and the southward flow of this deluge, joined to the direction which it would obtain from the rotatory motion of the globe, would of course produce that compound or south-easterly

direction which the phenomena require. All of these speculations are as yet far too deficient in facts to be of much value; and I must freely own that, for one, I attach little importance to them. All that we can legitimately infer from the diluvium is, that the northern parts of Europe and America were then under the sea, and that a strong current set over them.

Connected with the diluvium is the history of *ossiferous caverns*, of which specimens singly exist at Kirkdale in Yorkshire, Gailenreuth in Franconia, and other places. They occur in the calcareous strata, as the great caverns generally do, but have in all instances been naturally closed up till the recent period of their discovery. The floors are covered with what appears to be a bed of the diluvial clay, over which rests a crust of stalagmite, the result of the droppings from the roof since the time when the clay bed was laid down. In the instances above specified, and several others, there have been found, under the clay bed, assemblages of the bones of animals, of many various kinds. At Kirkdale, for example, the remains of twenty-four species were ascertained—namely, pigeon, lark, raven, duck, and partridge; mouse, water-rat, rabbit, hare, hippopotamus, rhinoceros, elephant,

weasel, fox, wolf, deer, (three species,) ox, horse, bear, tiger, hyena. From many of the bones of the gentler of these animals being found in a broken state, it is supposed that the cave was a haunt of hyenas and other predaceous animals, by which the smaller ones were here consumed. This must have been at a time antecedent to the submersion which produced the diluvium, since the bones are covered by a bed of that formation. It is impossible not to see here a very natural series of incidents. First, the cave is frequented by wild beasts, who make it a kind of charnel-house. Then, submerged in the current which has been spoken of, it receives a clay flooring from the waters containing that matter in suspension. Finally, raised from the water, but with no mouth to the open air, it remains unintruded on for a long series of ages, during which the clay flooring receives a new calcareous covering, from the droppings of the roof. Dr. Buckland, who examined and described the Kirkdale cave, was at first of opinion that it presented a physical evidence of the Noachian deluge; but he afterwards saw reason to consider its phenomena as of a time far apart from that event, which rests on evidence of an entirely different kind.

Our attention is next drawn to the erratic blocks

or boulders, which in many parts of the earth are thickly strewn over the surface, particularly in the north of Europe. Some of these blocks are many tons in weight, yet are clearly ascertained to have belonged originally to situations at a great distance. Fragments, for example, of the granite of Shap Fell are found in every direction around to the distance of fifty miles, one piece being placed high upon Criffel Mountain, on the opposite side of the Solway estuary; so also are fragments of the Alps found far up the slopes of the Jura. There are even blocks on the east coast of England, supposed to have travelled from Norway The only rational conjecture which can be formed as to the transport of such masses from so great a distance, is one which presumes them to have been carried and dropped by icebergs, while the space between their original and final sites was under ocean. Icebergs do even now carry off such masses from the polar coasts, which, falling when the retaining ice melts, must take up situations at the bottom of the sea analogous to those in which we find the erratic blocks of the present day.

As the diluvium and erratic blocks clearly suppose one last long submersion of the surface, (*last*,

geologically speaking,) there is another set of appearances which as manifestly shew the steps by which the land was made afterwards to reappear. These consist of *terraces*, which have been detected near, and at some distance inland from, the coast lines of Scandinavia, Britain, America, and other regions; being evidently ancient beaches, or platforms, on which the margin of the sea at one time rested. They have been observed at different heights above the present sea-level, from twenty to above twelve hundred feet; and in many places they are seen rising above each other in succession, to the number of three, four, and even more. The smooth flatness of these terraces, with generally a slight inclination towards the sea, the sandy composition of many of them, and, in some instances, the preservation of marine shells in the ground, identify them perfectly with existing sea-beaches, notwithstanding the cuts and scoopings which have at frequent intervals been effected in them by water-courses. The irresistible inference from the phenomena is, that the highest was first the coast line; then an elevation took place, and the second highest became so, the first being now raised into the air and thrown inland. Then, upon another elevation, the sea began to form, at its

new point of contact with the land, the third highest beach, and so on down to the platform nearest to the present sea-beach. Phenomena of this kind become comparatively familiar to us, when we hear of evidence that the last sixty feet of the elevation of Sweden, and the last eighty-five of that of Chili, have taken place since man first dwelt in those countries; nay, that the elevation of the former country goes on at this time at the rate of about forty-five inches in a century, and that a thousand miles of the Chilian coast rose four feet in one night, under the influence of a powerful earthquake, so lately as 1822. Subterranean forces, of the kind then exemplified in Chili, supply a ready explanation of the whole phenomena, though some other operating causes have been suggested. In an inquiry on this point, it becomes of consequence to learn some particulars respecting the levels. Taking a particular beach, it is generally observed that the level continues the same along a considerable number of miles, and nothing like breaks or hitches has as yet been detected in any case. A second and a third beach are also observed to be exactly parallel to the first. These facts would seem to indicate quiet elevating movements, uniform over a large tract. It must, how-

ever, be remarked that the raised beaches at one part of a coast rarely coincide with those at another part forty or fifty miles of. We might suppose this to indicate a limit in that extent of the uniformity of the elevating cause, but it would be rash to conclude positively that such is the case. In the present sea, as is well known, there are different levels at different places, owing to the operation of peculiar local causes, as currents, evaporation, and the influx of large rivers into narrow-mouthed estuaries. The differences of level in the ancient beaches might be occasioned by some such causes. But, whatever doubt may rest on this minor point, enough has been ascertained to settle the main one, that we have in these platforms indubitable monuments of the last rise of the land from the sea, and the concluding great event of the geological history.

The idea of such a wide-spread and possibly universal submersion unavoidably suggests some considerations as to the effect which it might have upon terrestrial animal life. It seems likely that this would be, on such an occasion, extensively, if not universally destroyed. Nor does the idea of its universal destruction seem the less plausible, when we remark, that none of the species of land

animals heretofore discovered can be detected at a subsequent period. The whole seem to have been now changed. Some geologists incline to think that there was at this time a new development of terrestrial animal life upon the globe, and M. Agassiz, whose opinion on such a subject is eminently worthy of attention, speaks all but decidedly for such a conclusion. It must, however, be owned, that proofs for it are still scanty, beyond the bare fact of a submersion which appears to have had a very wide range. I must therefore be content to leave this point, as far as geological evidence is concerned, for future determination.

There are some other superficial deposits, of less consequence on the present occasion than the diluvium—namely, lacustrine deposits, or filled-up lakes; alluvium, or the deposits of rivers beside their margins; deltas, the deposits made by great ones at their efflux into the sea; peat mosses; and the vegetable soil. The animal remains found in these generally testify to a zoology on the verge of that now prevailing, or melting into it, there being included many species which still exist. In a lacustrine deposit at Market-Weighton, in the Vale of York, there have been found bones of the elephant, rhinoceros, bison, wolf, horse, felis, deer,

birds, all or nearly all belonging to extinct species; associated with thirteen species of land and fresh-water shells, "exactly identical with types now living in the vicinity." In similar deposits in North America, are remains of the mammoth, mastodon, buffalo, and other animals of extinct and living types. In short, these superficial deposits show precisely such remains as might be expected from a time at which the present system of things (to use a vague but not unexpressive phrase) obtained, but yet so far remote in chronology as to allow of the dropping of many species, through familiar causes, in the interval. Still, however, there is no authentic or satisfactory instance of human remains being found, except in deposits obviously of very modern date; a tolerably strong proof that the creation of our own species is a comparatively recent event, and one posterior (generally speaking) to all the great natural transactions which have been here described.

GENERAL CONSIDERATIONS

RESPECTING

THE ORIGIN OF THE ANIMATED TRIBES.

Thus concludes the wondrous chapter of the earth's history which is told by geology. It takes up our globe at the period when its original incandescent state had nearly ceased ; conducts it through what we have every reason to believe were vast, or at least very considerable, spaces of time, in the course of which many superficial changes took place, and vegetable and animal life was gradually developed; and drops it just at the point when man was apparently about to enter on the scene. The compilation of such a history, from materials of so extraordinary a character, and the powerful nature of the evidence

which these materials afford, are calculated to excite our admiration, and the result must be allowed to exalt the dignity of science, as a product of man's industry and his reason.

If there is anything more than another impressed on our minds by the course of the geological history, it is, that the same laws and conditions of nature now apparent to us have existed throughout the whole time, though the operation of some of these laws may now be less conspicuous than in the early ages, from some of the conditions having come to a settlement and a close. That seas have flowed and ebbed, and winds disturbed their surfaces, in the time of the secondary rocks, we have proof on the yet preserved surfaces of the sands which constituted margins of the seas in those days. Even the fall of wind-slanted rain is evidenced on the same tablets. The washing down of detached matter from elevated grounds, which we see rivers constantly engaged in at the present time, and which is daily shallowing the seas adjacent to their mouths, only proceeded on a greater scale in earlier epochs. The volcanic subterranean force, which we see belching forth lavas on the

sides of mountains, and throwing up new elevations by land and sea, was only more powerfully operative in distant ages. To turn to organic nature, vegetation proceeded then exactly as now. The very alternation of the seasons has been read in unmistakable characters in sections of the trees of those days, precisely as it might be read in a section of a tree cut down yesterday. The system of prey amongst animals flourished throughout the whole of the pre-human period; and the adaptation of all plants and animals to their respective spheres of existence was as perfect in those early ages as it is still.

But, as has been observed, the operation of the laws may be modified by conditions. At one early age, if there was any dry land at all, it was perhaps enveloped in an atmosphere unfit for the existence of terrestrial animals, and which had to go through some changes before that condition was altered. In the carbonigenous era, dry land seems to have consisted only of clusters of islands, and the temperature was much above what now obtains at the same places. Volcanic forces, and perhaps also the disintegrating power, seem to

have been on the decrease since the first, or we have at least long enjoyed an exemption from such paroxysms of the former, as for certain prevailed at the close of the coal formation in England and throughout the tertiary era. The surface has also undergone a gradual progress by which it has become always more and more variegated, and thereby fitted for the residence of a higher class of animals.

In pursuing the progress of the development of both plants and animals upon the globe, we have seen an advance in both cases, from simple to higher forms of organization. In the botanical department, we have first sea, afterwards land plants; and amongst these the simpler (cellular and cryptogamic) before the more complex. In the department of zoology, we see, first, traces all but certain of infusoria; then polypiaria, crinoidea, and some humble forms of the articulata and mollusca; afterwards higher forms of the mollusca; and it appears that these existed for ages before there were any higher types of being. The first step forward gives fishes, the humblest class of the vertebrata; and, moreover, the earliest fishes

partake of the character of the lower sub-kingdom, the articulata. Afterwards come land animals, of which the first are reptiles, universally allowed to be the type next in advance from fishes, and to be connected with these by the links of an insensible gradation. From reptiles we advance to birds, and thence to mammalia, which are commenced by marsupialia, acknowledgedly low forms in their class. That there is thus a progress of some kind, the most superficial glance at the geological history is sufficient to convince us. Indeed, the doctrine of the gradation of animal forms has received a remarkable support from the discoveries of this science, as several types formerly wanting to a completion of the series have been found in a fossil state.

Fossil history has no doubt still some obscure passages; and these have been partially adverted to. Fuci, the earliest vegetable fossils as yet detected, are not, it has been remarked, the lowest forms of aquatic vegetation; neither are the plants

* Intervals in the series were numerous in the department of the pachydermata; many of these gaps are now filled up from the extinct genera found in the tertiary formation.

of the coal-measures the very lowest, though they are a low form, of land vegetation. There is here in reality no difficulty of the least importance. The humblest forms of marine and land vegetation are of a consistence to forbid all expectation of their being preserved in rocks. Had we possessed, contemporaneously with the fuci of the Silurians, or the ferns of the carboniferous formation, fossils of higher forms respectively, *equally unsubstantial*, but which had survived all contingencies, then the absence of mean forms of similar consistency might have been a stumbling-block in our course; but no such phenomena are presented. The blanks in the series are therefore no more than blanks; and when a candid mind further considers that the botanical fossils actually present are all in the order of their organic development, the whole phenomena appear exactly what might have been anticipated. It is also remarked, in objection, that the mollusca and articulata appear in the same group of rocks (the slate system) with polypiaria, crinoidea, and other specimens of the humblest sub-kingdom; some of the mollusca, moreover, being cephalopods, which are the highest of their division in point of

organization. Perhaps, in strict fact, the cephalopoda do not appear till a later time, that of the Silurian rocks. But even though the cephalopoda could be shewn as pervading all the lowest fossiliferous strata, what more would the fact denote than that, in the first seas capable of sustaining any kind of animal life, the creative energy advanced it, in the space of one formation, (no one can say how long a time this might be,) to the highest forms possible in that element, excepting such as were of vertebrate structure. It may here be inquired if geologists are entitled to set so high a value as they do upon the point in the scale of organic life which is marked by the upper forms of the mollusca. It will afterwards be seen that this is a low point compared with the whole scale, if we are to take as a criterion that parity of development which has been observed in the embryo of one of the higher animals. *The human embryo passes through the whole space representing the invertebrate animals in the first month, a mere fraction of its course.* There is indeed a remarkably rapid change of forms in such an embryo at first: the rapidity, says Professor Owen, is "in proportion to the proximity of

the ovum to the commencement of its development;" and, conformable to this fact, we find the same zoologist stating that, in the lowest division of the animal kingdom, (the Acrita of his arrangement,) there is a much quicker advance of forms towards the next above it, than is to be seen in subsequent departments. There is, indeed, to the most ordinary observation, a rapidity and force in the reproductive powers of the lowest animals, which might well suggest an explanation of that rush of life which seems to be indicated in the slate and Silurian rocks. With regard to the so-called early occurrence of fishes partaking of the saurian character, I would say that their occurrence a full formation after the earliest and simplest fishes, is, considering how little we know of the space of time represented by a formation, not early: their being later in any degree is the fact mainly important. The subsequent rise of new orders of fishes, fully piscine in character, may be explained by the supposition of their having been developed, as is most likely, from a different portion of the inferior sub-kingdom. In short, all the objections which have been made to the great fact of a general progress of

organic development throughout the geological ages, will be found, on close examination, to refer merely to doubtful appearances of small moment, which vanish into nothing when rightly understood.

It is nearly as evident, from the geological record, that the progress of organic life has observed some correspondence with the progress of physical conditions on the surface. We do not know for certain that the sea, at the time when it supported radiated, molluscous, and articulated families, was incapable of supporting fishes; but causes for such a limitation are far from inconceivable. The huge saurians appear to have been precisely adapted to the low muddy coasts and sea margins of the time when they flourished. Marsupials appear at the time when the surface was generally in that flat, imperfectly variegated state in which we find Australia, the region where they now live in the greatest abundance, and one which has no higher native mammalian type. Finally, it was not till the land and sea had come into their present relations, and the former, in its principal continents, had acquired the irregularity

of surface necessary for man, that man appeared. We have likewise seen reason for supposing that land animals could not have lived before the carbonigenous era, owing to the great charge of carbonic acid gas presumed to have been contained in the atmosphere down to that time. The surplus of this having gone, as M. Brongniart suggests, to form the vegetation whose ruins became coal, and the air being thus brought to its present state, land animals immediately appeared. So also, sea-plants were at first the only specimens of vegetation, because there appears to have been no place where other plants could be produced or supported. Land vegetation followed, at first simple, afterwards complex, probably in conformity with an advance of the conditions required by the higher class of plants. In short, we see everywhere throughout the geological history, strong traces of a parallel advance of the physical conditions and the organic forms.

A candid consideration of these circumstances can scarcely fail to introduce into our minds a somewhat different idea of organic creation from

what has hitherto been generally entertained. That God created animated beings, as well as the terraqueous theatre of their being, is a fact so powerfully evidenced, and so universally received, that I at once take it for granted. But in the particulars of this so highly supported idea, we surely see cause for some re-consideration. It may now be inquired,—In what way was the creation of animated beings effected? The ordinary notion may, I think, be described as this, — that the Almighty Author produced the progenitors of all existing species by some sort of personal or immediate exertion. But how does this notion comport with what we have seen of the gradual advance of species, from the humblest to the highest? How can we suppose an immediate exertion of this creative power at one time to produce zoophytes, another time to add a few marine mollusks, another to bring in one or two crustacea, again to produce crustaceous fishes, again perfect fishes, and so on to the end? This would surely be to take a very mean view of the Creative Power—to, in short, anthropomorphize it, or reduce it to some such character as that borne by

the ordinary proceedings of mankind. And yet this would be unavoidable; for that the organic creation was thus progressive through a long space of time, rests on evidence which nothing can overturn or gainsay. Some other idea must then be come to with regard to *the mode* in which the Divine Author proceeded in the organic creation. Let us seek in the history of the earth's formation for a new suggestion on this point. We have seen powerful evidence, that the construction of this globe and its associates, and inferentially that of all the other globes of space, was the result, not of any immediate or personal exertion on the part of the Deity, but of natural laws which are expressions of his will. What is to hinder our supposing that the organic creation is also a result of natural laws, which are in like manner an expression of his will? More than this, the fact of the cosmical arrangements being an effect of natural law, is a powerful argument for the organic arrangements being so likewise, for how can we suppose that the august Being who brought all these countless worlds into form by the simple establishment of a natural principle flowing from his mind, was to

interfere personally and specially on every occasion when a new shell-fish or reptile was to be ushered into existence on *one* of these worlds? Surely this idea is too ridiculous to be for a moment entertained.

It may be objected that the ordinary conceptions of Christian nations on this subject are directly derived from Scripture, or, at least, are in conformity with it; to which I would respectfully answer, that the Mosaic record appears, when perused with an awakened mind, much more in conformity with the present view than with that which has been so long entertained. All the procedure is there represented primarily and pre-eminently as flowing *from commands and expressions of will, not from direct acts.* Let there be light—let there be a firmament—let the dry land appear—let the earth bring forth grass, the herb, the tree—let the waters bring forth the moving creature that hath life—let the earth bring forth the living creature after his kind—these are the terms in which the principal acts are described. The additional expressions,—God made the firmament—God made the beast of the earth, &c., occur subordinately,

and only in a few instances; they do not necessarily convey a different idea of the mode of creation, and indeed only appear as alternative phrases, in the usual duplicative manner of Eastern narrative. Keeping this in view, the words used in a subsequent place, "God *formed* man in his own image," cannot well be understood as implying any more than what was implied before,—namely, that man was produced in consequence of an expression of the Divine will to that effect. Thus, the scriptural objection quickly vanishes, and the prevalent ideas about the organic creation appear only as a mistaken inference from the text, formed at a time when man's ignorance prevented him from drawing therefrom a just conclusion.

To a reasonable mind the Divine attributes must appear, not diminished or reduced in any way, by supposing a creation by law, but infinitely exalted. It is the narrowest of all views of the Deity, and characteristic of a humble class of intellects, to suppose him constantly acting in particular ways for particular occasions. It, for one thing, greatly detracts from his foresight, the most undeniable of all the attributes of Omnipotence. It lowers him to-

wards the level of our own humble intellects. Much more worthy of him it surely is, to suppose that all things have been commissioned by him from the first, though neither, as I shall afterwards endeavour to show, is he absent, in one important sense, from a particle of the current of natural affairs. Even in the business of the social world, if I may be allowed to adopt a familiar illustration, there is a constant progress from specific action for particular occasions, to arrangements which, once established, shall continue to answer for a great multitude of occasions. Such plans the enlightened readily form for themselves, and conceive as being adopted by all who have to attend to a multitude of affairs, while the ignorant suppose every act of the greatest public functionary to be the result of some special consideration and care on his part alone. Are we to suppose the Deity adopting plans which harmonize only with the modes of procedure of the less enlightened of our race? Those who would object to the hypothesis of a creation by the intervention of law, do not perhaps consider how powerful an argument in favour of the existence of God is lost by rejecting this doctrine. When all is seen

to be the result of law, the idea of an Almighty Author becomes irresistible, for the creation of a law for an endless series of phenomena—an act of intelligence above all else that we can conceive —could have no other imaginable source, and tells, moreover, as strongly for a sustaining as for an originating power. On this point a remark of Dr. Buckland seems applicable: "If the properties adopted by the elements at the moment of their creation adapted them beforehand to the infinity of complicated useful purposes which they have already answered, and may have still farther to answer, under many dispensations of the material world, such an aboriginal constitution, so far from superseding an intelligent agent, would only exalt our conceptions of the consummate skill and power that could comprehend such an infinity of future uses under future systems, in the original groundwork of his creation."

A late writer, in a work embracing a vast amount of miscellaneous knowledge, but written in a dogmatic style, argues at great length for the doctrine of more immediate exertions on the part of the Deity in the works of his creation. One of

the most striking of his illustrations is as follows:—"The coral polypi, united by a common animal bond, construct a defined form in stone; many kinds construct many forms. An allotted instinct may permit each polypus to construct its own cell, but there is no superintending one to direct the pattern, nor can the workers unite by consultation for such an end. There is no recipient for an instinct by which the pattern might be constructed. It is God alone, therefore, who is the architect; and for this end, consequently, he must dispose of every new polypus required to continue the pattern, in a new and peculiar position, which the animal could not have discovered by itself. Yet more, millions of these blind workers unite their works to form an island, which is also wrought out according to a constant general pattern, and of a very peculiar nature, though the separate coral works are numerously diverse. Still less, then, here, is an instinct possible. The Great Architect himself must execute what he planned, in each case equally. He uses these little and senseless animals as hands; but they are hands which himself must direct. He must direct each one every-

where, and therefore he is ever acting."* This is a notable example of a dangerous kind of reasoning. It is now believed that corals have a general life and sensation throughout the whole mass, residing in the tissue which envelops them; consequently, there is nothing more wonderful in their determinate general forms than in those of other animals.

It may here be remarked that there is in the present doctrine that harmony in all the associated phenomena which generally marks great truths. First, it agrees, as we have seen, with the idea of planet-creation by natural law. Secondly, upon this supposition, all that geology tells us of the succession of species appears natural and intelligible. Organic life *presses in*, as has been remarked, wherever there is room and encouragement for it, the forms being always such as suit the circumstances, and in a certain relation to them, as, for example, where the limestone-forming seas produce an abundance of corals, crinoidea, and shell-fish. How well the extensive changes of species which are evidenced by geology, comport with our view

* Macculloch on the Attributes of the Deity, iii. 569.

of the details of law-creation, will be seen when these come to be explained. The more solitary commencements of species, which would have been the most inconceivably paltry exercise for an immediately creative power, are sufficiently worthy of one operating by laws.

It is also to be observed, that the thing to be accounted for is not merely the origination of organic being upon this little planet, third of a series which is but one of hundreds of thousands of series, the whole of which again form but one portion of an apparently infinite globe-peopled space, where all seems analogous. We have to suppose, that every one of these numberless globes is either a theatre of organic being, or in the way of becoming so. This is a conclusion which every addition to our knowledge makes only the more irresistible. Is it conceivable, as a fitting mode of exercise for creative intelligence, that it should be constantly moving from one sphere to another, to form and plant the various species which may be required in each situation at particular times? Is such an idea accordant with our general conception of the dignity, not to speak of the power,

of the Great Author? Yet such is the notion which we must form, if we adhere to the doctrine of special exercise. Let us see, on the other hand, how the doctrine of a creation by law agrees with this expanded view of the organic world.

Unprepared as most men may be for such an announcement, there can be no doubt that we are able, in this limited sphere, to form some satisfactory conclusions as to the plants and animals of those other spheres which move at such immense distances from us. Suppose that the first persons of an early nation who made a ship and ventured to sea in it, observed, as they sailed along, a set of objects which they had never before seen—namely, a fleet of other ships—would they not have been justified in supposing that those ships were occupied, like their own, by human beings possessing hands to row and steer, eyes to watch the signs of the weather, intelligence to guide them from one place to another—in short, beings in all respects like themselves, or only shewing such differences as they knew to be producible by difference of climate and habits of life? Precisely in this manner

we can speculate on the inhabitants of remote spheres. We see that matter has originally been diffused in one mass, of which the spheres are portions. Consequently, inorganic matter must be presumed to be everywhere the same, although probably with differences in the proportions of ingredients in different globes, and also some difference of conditions. Out of a certain number of the elements of inorganic matter are composed organic bodies, both vegetable and animal; such must be the rule in Jupiter and in Sirius, as it is here. We, therefore, are all but certain that herbaceous and ligneous fibre, that flesh and blood, are the constituents of the organic beings of all those spheres which are as yet seats of life. Gravitation we see to be an all-pervading principle: therefore there must be a relation between the spheres and their respective organic occupants, by virtue of which they are fixed, as far as necessary, on the surface. Such a relation, of course, involves details as to the density and elasticity of structure, as well as size, of the organic tenants, in proportion to the gravity of the respective planets—peculiarities, however, which may quite well con-

sist with the idea of a universality of general types, to which we are about to come. Electricity we also see to be universal; if, therefore, it be a principle concerned in life and in mental action, as science strongly suggests, life and mental action must everywhere be of one general character. We come to comparatively matter of detail, when we advert to heat and light; yet it is important to consider that these are universal agents, and that, as they bear marked relations to organic life and structure on earth, they may be presumed to do so in other spheres also. The considerations as to light are particularly interesting, for, on our globe, the structure of one important organ, almost universally distributed in the animal kingdom, is in direct and precise relation to it. Where there is light there will be eyes, and these, in other spheres, will be the same in all respects as the eyes of tellurian animals, with only such differences as may be necessary to accord with minor peculiarities of condition and of situation. It is but a small stretch of the argument to suppose that, one conspicuous organ of a large portion of our animal kingdom being thus universal, a parity in all the other organs—species for species, class for class, kingdom for kingdom—is highly likely, and that

thus the inhabitants of all the other globes of space bear not only a general, but a particular resemblance to those of our own.

Assuming that organic beings are thus universally distributed, the idea of their having all come into existence by the operation of laws everywhere applicable, is only conformable to that principle, acknowledged to be so generally visible in the affairs of Providence, to have everything done by the employment of the smallest possible amount of means. Thus, as one set of laws produced all orbs and their motions and geognostic arrangements, so one set of laws overspread them all with life. The whole productive or creative arrangements are therefore in perfect unity.

PARTICULAR CONSIDERATIONS

RESPECTING

THE ORIGIN OF THE ANIMATED TRIBES.

The general likelihood of an organic creation by law having been shewn, we are next to inquire if science has any facts tending to bring the assumption more nearly home to nature. Such facts there certainly are; but it cannot be surprising that they are comparatively few and scattered, when we consider that the inquiry is into one of nature's profoundest mysteries, and one which has hitherto engaged no direct attention in almost any quarter.

Crystallization is confessedly a phenomenon of inorganic matter; yet the simplest rustic observer is struck by the resemblance which the examples of it left upon a window by frost bear to vegetable forms. In some crystallizations the mimicry is

beautiful and complete; for example, in the well-known one called the *Arbor Dianæ.* An amalgam of four parts of silver and two of mercury being dissolved in nitric acid, and water equal to thirty weights of the metals being added, a small piece of soft amalgam of silver, suspended in the solution, quickly gathers to itself the particles of the silver of the amalgam, which form upon it a *crystallization precisely resembling a shrub.* Vegetable figures are also presented in some of the most ordinary appearances of the electric fluid. In the marks caused by positive electricity, or which it leaves in its passage, we see the ramifications of a tree, as well as of its individual leaves; those of the negative, recal the bulbous or the spreading root, according as they are clumped or divergent. These phenomena seem to say that the electric energies have had something to do in determining the forms of plants. That they are intimately connected with vegetable life is indubitable, for germination will not proceed in water charged with negative electricity, while water charged positively greatly favours it; and a garden sensibly increases in luxuriance, when a number of conducting rods are made to terminate in branches over its beds. With regard to the resemblance of the ramifica-

tions of the branches and leaves of plants to the traces of the positive electricity, and that of the roots to the negative, it is a circumstance calling for especial remark, that the atmosphere, particularly its lower strata, is generally charged positively, while the earth is always charged negatively. The correspondence here is curious. A plant thus appears as a thing formed on the basis of a natural electrical operation—*the brush* realized. We can thus suppose the various forms of plants as, immediately, the result of a law in electricity variously affecting them according to their organic character, or respective germinal constituents. In the poplar, the brush is unusually vertical, and little divergent; the reverse in the beech: in the palm, a pencil has proceeded straight up for a certain distance, radiates there, and turns outwards and downwards; and so on. We can here see at least traces of secondary means by which the Almighty Deviser might establish all the vegetable forms with which the earth is overspread.

Vegetable and animal bodies are mainly composed of the same four simple substances or elements—carbon, oxygen, hydrogen, and nitrogen. The first combinations of these in animals are into what are called proximate principles, as albumen,

fibrin, &c., out of which the structure of the animal body is composed. Now it is acknowledged by Dr. Daubeny, that in the combinations forming the proximate principles there is no chemical peculiarity. "It is now certain," he says, "that the same simple laws of composition pervade the whole creation; and that, if the organic chemist only takes the requisite precautions to avoid resolving into their ultimate elements the proximate principles upon which he operates, the result of his analysis will shew that they are combined precisely according to the same plan as the elements of mineral bodies are known to be."* A particular fact is here worthy of attention. "The conversion of fecula into sugar, as one of the ordinary processes of vegetable economy, is effected by the production of a secretion termed *diastase*, which occasions both the rupture of the starch vesicles, and the change of their contained gum into sugar. This diastase may be separately obtained by the chemist, and it acts as effectually in his laboratory as in the vegetable organization. He can also imitate its effects by other chemical agents."† The writer quoted below adds, "No

* Supplement to the Atomic Theory.

† Carpenter on Life; Todd's Cyclopædia of Physiology.

reasonable ground has yet been adduced for supposing that, if we had the power of bringing together the elements of any organic compound, in their requisite states and proportions, the result would be any other than that which is found in the living body."

It is much to know the elements out of which organic bodies are composed. It is something more to know their first combinations, and that these are simply chemical. How these combinations are associated in the structure of living bodies is the next inquiry, but it is one to which as yet no satisfactory answer can be given. The investigation of the minutiæ of organic structure by the microscope is of such recent origin, that its results cannot be expected to be very clear. Some facts, however, are worthy of attention with regard to the present inquiry. It is ascertained that the basis of all vegetable and animal substances consists of nucleated cells; that is, cells having granules within them. Nutriment is converted into these before being assimilated by the system. The tissues are formed from them. The ovum destined to become a new creature, is originally only a cell with a contained granule. We see it acting this reproductive part in the simplest man-

ner in the cryptogamic plants. "The parent cell, arrived at maturity by the exercise of its organic functions, bursts, and liberates its contained granules. These, at once thrown upon their own resources, and entirely dependent for their nutrition on the surrounding elements, develop themselves into new cells, which repeat the life of their original. Amongst the higher tribes of the cryptogamia, the reproductive cell does not burst, but the first cells of the new structure are developed within it, and these gradually extend, by a similar process of multiplication, into that primary leaf-like expansion which is the first formed structure in all plants."* *Here the little cell becomes directly a plant, the full formed living being.* It is also worthy of remark that, in the sponges, (an animal form,) a gemmule detached from the body of the parent, and trusting for sustentation only to the fluid into which it has been cast, becomes, without further process, the new creature. Further, it has been recently discovered by means of the microscope, that there is, as far as can be judged, a perfect resemblance between the ovum of the mammal tribes, during that early stage when it is passing

* Carpenter's Report on the results obtained by the Microscope in the study of Anatomy and Physiology, 1843.

through the oviduct, and the young of the infusory animalcules. One of the most remarkable of these, the *volvox globator,* has exactly the form of the germ which, after passing through a long fœtal progress, becomes a complete mammifer, an animal of the highest class. It has even been found that both are alike provided with those *cilia,* which, producing an appearance of revolving motion, is partly the cause of the name given to this animalcule. These resemblances are the more entitled to notice, that they were made by various observers, distant from each other at the time.* It has likewise been noted that the globules of the blood are reproduced by the expansion of contained granules; they are, in short, *distinct organisms multiplied by the same fissiparous generation.* So that all animated nature may be said to be based on this mode of origin; *the fundamental form of organic being is a globule, having a new globule forming within itself,* by which it is in time discharged, and which is again followed by another and another, in endless succession. It is of course obvious that, if these globules could be produced by any process from inorganic elements, we should

* See Dr. Martin Barry on Fissiparous Generation; Jameson's Journal, Oct. 1843.

be entitled to say that the fact of a transit from the inorganic into the organic had been witnessed in that instance; the possibility of the commencement of animated creation by the ordinary laws of nature might be considered as established. Now it was announced some years ago by the French physiologists Prevost and Dumas, that *globules could be produced in albumen by electricity.* If, therefore, these globules be identical with the cells which are now held to be reproductive, it might be said that the production of albumen by artificial means is the only step in the process wanting. This has not yet been effected; but it is known to be only a chemical process, the mode of which may be any day discovered in the laboratory.*

* The reader will please to understand that the above paragraph is only a humble attempt to bring illustration from a department of science on which at present much doubt and obscurity rest. I have followed the best lights I could find, but cannot be assured that better will not yet be evolved from the researches of the many able physiologists now engaged in the investigation of ultimate structure and of embryology. I am bound to admit, in the meantime, that the identity of the globules produced in albumen by electricity with *living cells*, and the fact of the reproduction of living globules, are both doubted by physiologists of high character. In this, as in other instances, I believe that particular illustrations may be held in doubt, or may altogether fail, without necessary injury to my general argument.

In such an investigation as the present, it is not unworthy of notice, that the production of shell is a natural operation which can be precisely imitated artificially. Such an incrustation takes place on both the outside and inside of the wheel in a bleaching establishment, in which cotton cloth is rinsed free of the lime employed in its purification. From the *dressing* employed by the weaver, the cloth obtains the animal matter, *gelatin;* this and the lime form the constituents of the incrustation, exactly as in natural shell. In the wheel employed at Catrine, in Ayrshire, where the phenomenon was first observed by the eye of science, it had required ten years to produce a coating the tenth of an inch in thickness. This incrustation has all the characters of shell, displaying a highly polished surface, beautifully iridescent, and, when broken, a foliated texture. The examination of it has even thrown some light on the character and mode of formation of natural shell. "The plates into which the substance is divisible have been formed in succession, and certain intervals of time have elapsed between their formation; in general, every two contiguous laminæ are separated by a thin iridescent film, varying from the three to the fifty millionth part of an inch in thickness, and pro-

ducing all the various colours of thin plates which correspond to intermediate thicknesses: between some of the laminæ no such film exists, probably in consequence of the interval of time between their formation being too short; and between others the film has been formed of unequal thickness. There can be no doubt that these iridescent films are formed when the dash-wheel is at rest during the night, and that when no film exists between two laminæ, an interval too short for its formation, (arising, perhaps, from the stopping of the work during the day,) has elapsed during the drying or induration of one lamina and the deposition of another."* From this it has been deduced, by a patient investigation, that those colours of mother-of-pearl, which are incommunicable to wax, arise from iridescent films deposited between the laminæ of its structure, and it is hence inferred that *the animal,* like the wheel, *rests periodically from its labours in forming the natural substance.*

These, it will be owned, are curious and not irrelevant facts; but it will be asked what actual experience says respecting the origination of life.

* Mr. Leonard Horner and Sir David Brewster, on a substance resembling shell.—*Philosophical Transactions*, 1836.

Are there, it will be said, any authentic instances of either plants or animals, of however humble and simple a kind, having come into existence otherwise than in the ordinary way of generation, since the time of which geology forms the record? To this it may be answered, in the first place, that the negative of the question could not be by any means formidable to the doctrine of law-creation, seeing that the conditions necessary for the operation of the supposed life-creating laws may not have existed within record to any great extent. There may have never been an instance of the origination of life, otherwise than by generation, since the commencement of the human species, and nevertheless the doctrine in question may be shewn upon grounds altogether apart to have strong probability on its side. On the other hand, as we see the physical laws of early times still acting with more or less force, it might not be unreasonable to expect that we should still see some remnants, or partial and occasional workings of the life-creating energy amidst a system of things generally stable and at rest. Are there, then, any such remnants to be traced in our own day, or during man's existence upon earth? If there be, it clearly would form a strong evidence in favour

of the doctrine, as what now takes place upon a confined scale, and in a comparatively casual manner, may have formerly taken place on a great scale, and as the proper and eternity-destined means of supplying a vacant globe with suitable tenants. It will at the same time be observed that, the earth being now supplied with both kinds of tenants in great abundance, we only could expect to find the life-originating power at work in some very special and extraordinary circumstances, and probably only in the inferior and obscurer departments of the vegetable and animal kingdoms.

Perhaps, if the question were asked of ten men of approved reputation in science, nine out of the number would answer in the negative. This is because, in a great number of instances where the superficial observers of former times assumed a non-generative origin for life, (as in the celebrated case in Virgil's fourth Georgic,) either the direct contrary has been ascertained, or exhaustive experiments have left no alternative from the conclusion that ordinary generation did take place, albeit in a manner which escapes observation. Finding that an erroneous assumption has been formed in many cases, modern inquirers have not hesitated to assume that there can be no case in

which generation is not concerned. Now their conclusion may be right, but it clearly is not one beyond question; and it is equally true that the explanations suggested in difficult cases are often far from being satisfactory. When, for instance, lime is laid down upon a piece of waste moss ground, and a crop of white clover for which no seeds were sown is the consequence, the common explanation is, that the seeds have been dormant there for an unknown time, and were stimulated into germination when the lime produced the appropriate circumstances. How is it possible to be satisfied with this hypothesis, when we know (as in an authentic case under my notice) that the spot is many miles from where clover is cultivated, and that there is nothing for six feet below but pure peat moss, clover seeds being, moreover, known to be too heavy to be transported, as many other seeds are, by the winds?

There are several persons eminent in science who profess at least to find great difficulties in accepting the doctrine of invariable generation. One of these* has stated several considerations arising from analogical reasoning, which appear to him to

* Dr. Allen Thomson, in the article *Generation*, in Todd's Cyclopædia of Anatomy and Physiology.

throw the balance of evidence in favour of the primitive production of infusoria, the vegetation called mould, and the like. One seems to be of great force; namely, that the animalcules, which are supposed (altogether hypothetically) to be produced by ova, are afterwards found increasing their numbers, not by that mode at all, but by division of their bodies. If it be the nature of these creatures to propagate in this splitting or fissiparous manner, how could they be communicated to a vegetable infusion? It has been shewn by the opponents of this theory, that when a vegetable infusion is debarred from the contact of the atmosphere, by being closely sealed up or covered with a layer of oil, no animalcules are produced; but it has been said, on the other hand, that the exclusion of the air may prevent some simple condition necessary for the aboriginal development of life—and nothing is more likely. Perhaps the prevailing doctrine is in nothing placed in greater difficulties than it is with regard to the entozoa, or creatures which live within the bodies of others. These creatures do, and apparently can, live nowhere else than in the interior of other living bodies, where they generally take up their abode in the viscera, but also sometimes in the chambers

of the eye, the interior of the brain, the serous sacs, and other places having no communication from without. Some are viviparous, others oviparous. Of the latter it cannot reasonably be supposed that the ova ever pass through the medium of the air, or through the blood-vessels, for they are too heavy for the one transit, and too large for the other. Of the former, it cannot be conceived how they pass into young animals—certainly not by communication from the parent, for it has often been found that entozoa do not appear in certain generations of a human family, and some of peculiar and noted character have only appeared at rare intervals, and in very extraordinary circumstances. A candid view of the less popular doctrine, as to the origin of this humble form of life, is taken by a distinguished living naturalist. "To explain the beginning of these worms within the human body, on the common doctrine that all created beings proceed from their likes, or a primordial egg, is so difficult, that the moderns have been driven to speculate, as our fathers did, on their spontaneous birth; but they have received the hypothesis with some modification. Thus it is not from putrefaction or fermentation that the entozoa are born, for both of these processes are rather fatal to their existence,

but from the aggregation and fit apposition of matter which is already organized, or has been thrown from organized surfaces. * * Their origin in this manner is not more wonderful or more inexplicable than that of many of the inferior animals from sections of themselves. * * Particles of matter fitted by digestion, and their transmission through a living body, for immediate assimilation with it, or flakes of lymph detached from surfaces already organized, seem neither to exceed nor fall below that simplicity of structure which favours this wonderful development; and the supposition that, like morsels of a planaria, they may also, when retained in contact with living parts, and in other favourable circumstances, continue to live and be gradually changed into creatures of analogous conformation, is surely not so absurd as to be brought into comparison with the Metamorphoses of Ovid. * * We think the hypothesis is also supported in some degree by the fact, that the origin of the entozoa is favoured by all causes which tend to disturb the equality between the secerning and absorbent systems."† Here particles of organized matter are suggested as the germinal original of

† Article "Zoophytes," Encyclopædia Britannica, 7th edition.

distinct and fully organized animals, many of which have a highly developed reproductive system. How near such particles must be to the inorganic form of matter may be judged from what has been said within the last few pages. If, then, this view of the production of entozoa be received, it must be held as in no small degree favourable to the general doctrine of an organic creation by law.*

There is another series of facts, akin to the above, and which deserve not less attention. The pig, in its domestic state, is subject to the attacks of a hydatid, from which the wild animal is free; hence the disease called measles in pork. The domestication of the pig is of course an event

* A more general, but more arresting argument in favour of primitive production, though not conclusively so, has been presented in the following terms:—

"We see a simple germ—the nucleus of a cell—develop itself into a feeling, moving, thinking man, by drawing into itself, and combining into new forms, the particles of what we are accustomed to call inorganic matter. These new forms are caused, by the very act of combination, to manifest properties of a new and peculiar kind; and their actions constitute the life of the being. Hence we must attribute to all those substances, which are thus drawn from the inorganic into the organic mode of existence, *a latent capacity* for the latter;—just as we say that the oxygen, hydrogen, carbon, and nitrogen, which make up the organic substance termed muscular fibre, and which, in *that* state or mode of combination, possess certain vital properties, possess also

subsequent to the origin of man; indeed, comparatively speaking, a recent event. Whence, then, the first progenitor of this hydatid? So also there is a tinea which attacks dressed wool, but never touches it in its unwashed state. A particular insect disdains all food but chocolate, and the larva of the *oinopota cellaris* lives nowhere but in wine and beer, all of these being articles manufactured by man. There is likewise a creature called the *pymelodes cyclopum*, which is only found in subterranean cavities connected with certain specimens of the volcanic formation in South America, dating from a time posterior to the arrangements of the earth for our species. Whence

a latent capacity for combining in that mode of aggregation termed crystalline, and for exhibiting the solubility, translucency, and other qualities of a salt (all of which are totally opposed to its vital properties, and cannot co-exist with them), when united into the form of cyanate of ammonia. If we were only acquainted with those elements as they exist in organic compounds, their transposition into a crystalline salt would be almost as marvellous to us as the opposite change is now. If this *latent organizability or vitality* be admitted (as we conceive logical proof to have been given that it must), as a property of a large proportion of what we call inorganic matter, is there any such wonderful difficulty in imagining that it may be brought into play in some other manner than by the agency of a pre-existing germ? We think not. But let further investigation and more extended experience decide."—*British and Foreign Medical Review*, January, 1845.

the first pymelodes cyclopum? Will it, to a geologist, appear irrational to suppose that, just as the pterodactyle was added as a new offshoot from the animal stock, in the era of the new red sandstone, when the earth had become suited for such a creature, so may these creatures have been added when media suitable for their existence arose, and that such phenomena may take place any day, the only cause for their taking place seldom being the rarity of the rise of new physical conditions on a globe which seems to have already undergone the principal part of its destined mutations?

Between such isolated facts and the greater changes which attended various geological eras, it is not easy to see any difference, besides simply that of the scale on which the respective phenomena took place, as the throwing off of one copy from an engraved plate is exactly the same process as that by which a thousand are thrown off. To Creative Providence, we may well conceive, the numbers of such phenomena, the time when, and the circumstances under which they take place, are indifferent matters. The Eternal One has arranged for everything beforehand, and trusted all to the operation of the laws of his appointment, himself being ever present in all things. We can even conceive that man, in his many doings upon the

surface of the earth, may occasionally, without his being aware of it, or otherwise, act as an instrument in preparing the association of conditions under which the creative laws work; and perhaps some instancës of his having acted as such an instrument have actually occurred in our own time.

I allude, of course, to the experiments conducted a few years ago by Mr. Crosse, which seemed to result in the production of a heretofore unknown species of insect in considerable numbers. Various causes have prevented these experiments and their results from receiving candid treatment, but they may perhaps be yet found to have opened up a new and most interesting chapter of nature's mysteries. Mr. Crosse was pursuing some experiments in crystallization, causing a powerful voltaic battery to operate upon a saturated solution of silicate of potash, when the insects unexpectedly made their appearance. He afterwards tried nitrate of copper, which is a deadly poison, and from that fluid also did live insects emerge. Discouraged by the reception of his experiments, Mr. Crosse soon discontinued them; but they were some years after pursued by Mr. Weekes, of Sandwich, with precisely the same results. This gentleman, besides trying the first of the above substances, employed ferro-cyanuret of potassium

on account of its containing a larger proportion of carbon, the principal element of organic bodies; and from this substance the insects were produced *in increased numbers.* A few weeks sufficed for this experiment, with the powerful battery of Mr. Crosse; but the first attempts of Mr. Weekes required about eleven months, a ground of presumption in itself that the electricity was chiefly concerned in the phenomenon. The changes undergone by the fluid operated upon, were in both cases remarkable, and nearly alike. In Mr. Weekes's apparatus, the silicate of potash became first turbid, then of a milky appearance; round the negative wire of the battery, dipped into the fluid, there gathered a quantity of *gelatinous matter,* a part of the process which is very striking, when we remember that gelatin is one of the *proximate principles,* or first compounds, out of which animal bodies are formed, though, of course, we should require further proof to satisfy us that the matter here concerned was actually gelatin. From the matter, whatever was its nature, Mr. Weekes observed one of the insects in the very act of emerging, immediately after which it ascended to the surface of the fluid, and sought concealment in an obscure corner of the apparatus. The insects produced by both experimentalists seem

to have been the same, a species of acarus, minute and semi-transparent, and furnished with long bristles, which can only be seen by the aid of the microscope. It is worthy of remark, that some of these insects, soon after their existence had commenced, were found to be likely to extend their species. They were sometimes observed to go back to the fluid to feed, and occasionally they devoured each other.*

The reception of novelties in science must ever be regulated very much by the amount of kindred or relative phenomena which the public mind already possesses and acknowledges, to which the new can be assimilated. A novelty, however true, if there be no received truths with which it can be shewn in harmonious relation, has little chance of a favourable hearing. In fact, as has been often observed, there is a measure of incredulity from our ignorance as well as from our knowledge, and if the most distinguished philosopher three hundred years ago had ventured to develop any striking new fact which only could harmonize with the as yet unknown Copernican solar system, we cannot doubt that it would have been universally scoffed at in the scientific world, such as it then was, or, at the best, interpreted in a

* See a Pamphlet circulated by Mr. Weekes, in 1842.

thousand wrong ways in conformity with ideas already familiar. The experiments above described, finding a public mind which had never discovered a fact or conceived an idea at all analogous, were of course ungraciously received. It was held to be impious even to surmise that animals could have been formed through any instrumentality of an apparatus devised by human skill. The more likely account of the phenomena was said to be, that the insects were only developed from ova, resting either in the fluid, or in the wooden frame on which the experiments took place. On these objections the following remarks may be made. The supposition of impiety arises from an entire misconception of what is implied by an aboriginal creation of insects. The experimentalist could never be considered as the author of the existence of these creatures, except by the most unreasoning ignorance. The utmost that can be claimed for, or imputed to him is, that he arranged the natural conditions under which the true creative energy—that flowing from the primordial appointment of the Divine Author of all things—was pleased to work in that instance. On the hypothesis here brought forward, the *acarus Crossii* was

a type of being ordained from the beginning, and destined to be realized under certain physical conditions. When a human hand brought these conditions into the proper arrangement, it did an act akin to hundreds of familiar ones which we execute every day, and which are followed by natural results; but it did nothing more. The production of the insect, if it did take place as assumed, was as clearly an act of the Almighty himself, as if he had fashioned it with hands. For the presumption that an act of aboriginal creation did take place, there is this to be said, that, in Mr. Weekes's experiment, every care that ingenuity could devise was taken to exclude the possibility of a development of the insects from ova. The wood of the frame was baked in a powerful heat; a bell-shaped glass covered the apparatus, and from this the atmosphere was excluded by the fumes constantly rising from the liquid, for the emission of which there was an aperture so arranged at the top of the glass, that only these fumes could pass. The water was distilled, and the substance of the silicate had been subjected to white heat. Thus every source of fallacy seemed to be shut up. In such circumstances, a candid mind, which sees nothing either impious or unphilosophical in the idea of a new creation,

will be disposed to think that there is less difficulty in believing in such a creation having actually taken place, than in believing that, in two instances, separated in place and time, exactly the same insects should have chanced to arise from concealed ova, and these of a species heretofore unknown.*

* The writer of the critique upon this work in the *British and Foreign Medical Review*, after saying that "none of the easy solutions which have been offered of the difficult problem presented by the appearance of this acarus, can be admitted," proceeds to make a few remarks much to the above purpose; and adds—"Not the least curious part of its (the acarus's) history is the series of metamorphoses which it undergoes before quitting the solution; these being *entirely different from the very slight changes which other acari undergo after their emersion from the egg.* Further, we believe it may be positively asserted, that, in whatever mode these acari are first generated, *it is not from eggs*; since, after they have escaped from the solution, they live in the neighbourhood, and readily breed; and their eggs, which we have ourselves seen, are quite large enough to have been readily visible in the solution, had they existed there."

The metamorphoses here adverted to will perhaps go some way to satisfy those who have objected that the acarus, belonging as it does to the articulata, is too high an animal to have been produced otherwise than from ova.

I would, nevertheless, remark that the Acarus Crossii is only brought forward as one illustration, and in order that a hypothesis which I think has strong probabilities on its side may have the benefit of any doubts that can be instituted with regard to the production of this creature. The decision of the question against the conclusion here leant to, would still leave much sound illustration, and not in the least affect the *general* argument.

HYPOTHESIS OF THE DEVELOPMENT OF THE VEGETABLE AND ANIMAL KINGDOMS.

It has been already intimated, as a general fact, that there is an obvious gradation amongst the families of both the vegetable and animal kingdoms, from the simple lichen and animalcule respectively up to the highest order of dicotyledonous trees and mammalia. Confining our attention, on this occasion, to the animal kingdom—it is to be observed that the gradation is much less simple and direct than is generally supposed. It certainly does not proceed, at all parts of its course at least, upon one line; for the two sub-kingdoms of middle rank, mollusca and articulata, form unquestionably two distinct approaches to the highest, the vertebrata. It even appears that there are intimations of more than two lines at various parts of the ani-

mal scale, as will be afterwards more particularly explained. Nevertheless, no doubt is entertained by any naturalist of a general advance of organization from the radiate into both the molluscous and articulate forms, and from the latter of these again (if not the former also) into the vertebrate; as also along the classes of (for example) the vertebrata, in this sequence—fishes, reptiles, birds, mammals.

While the external forms of all these various animals are so different, it is very remarkable that the whole are, after all, variations of a fundamental plan, which can be traced as a basis throughout the whole, the variations being merely modifications of that plan to suit the particular conditions in which each particular animal has been designed to live. Starting from the primeval germ, which, as we have seen, is the representative of a particular order of full-grown animals, we find all others to be merely advances from that type, with the extension of endowments and modification of forms which are required in each particular case; each form, also, retaining a strong affinity to that which precedes it, and tending to impress its own features on that which succeeds. This unity of structure, as it is called, becomes the more remarkable, when we observe that the organs, while pre-

serving a resemblance, are often put to different uses. For example: the ribs become, in the serpent, organs of locomotion, and the snout is extended, in the elephant, into a prehensile instrument.

It is equally remarkable that analogous purposes are served in different animals by organs essentially different. Thus, the mammalia breathe by lungs; the fishes, by gills. These are not modifications of one organ, but distinct organs. In mammifers, the gills exist and act at an early stage of the fœtal state, but afterwards go back and appear no more; while the lungs are developed. In fishes, again, the gills only are fully developed; while the lung structure either makes no advance at all, or only appears in the rudimentary form of an air-bladder. So, also, the baleen of the whale and the teeth of the land mammalia are different organs. The whale, in embryo, shews the rudiments of teeth; but these, not being wanted, are not developed, and the baleen is brought forward instead. The land animals, we may also be sure, have the rudiments of baleen in their organization. In many instances, a particular structure is found advanced to a certain point in a particular set of animals, (for instance, feet in the serpent tribe,) although it is not there required in any degree;

but the peculiarity, being carried a little farther forward, is perhaps useful in the next set of animals in the scale. In other instances, a portion of organization necessary in one sex is also presented in the other, where it is not necessary. For example, the mammæ of the human female, by whom these organs are obviously required, also exist in the male, who has no occasion for them. It might be supposed that in this case there was a regard to uniformity for mere appearance sake; but that no such principle is concerned, appears from a much more remarkable instance connected with the marsupial animals. The female of that tribe has a process of bone advancing from the pubes for the support of her pouch; and this also appears in the male marsupial, who has no pouch, and requires none. The rudimentary organs, as those not fully developed for use are called, appear most conspicuously in animals which form links between various classes.

As formerly stated, the marsupials, standing at the bottom of the mammalia, shew their affinity to the oviparous vertebrata, by the rudiments of two canals passing from near the anus to the external surfaces of the viscera, which are fully developed in fishes, being required by them for the respi-

ration of aërated waters, but which are not needed by the atmosphere-breathing marsupials. We have also the peculiar form of the sternum and rib-bones of the lizards *represented* in the mammalia in certain white cartilaginous lines traceable among their abdominal muscles. The ostrich is an elevated form of the birds, approaching to be on a level with the mammalia, and in it we find the wings imperfectly or not at all developed, a diaphragm and urinary sac, (organs wanting in other birds,) and feathers approaching the nature of hair. Again, the ornithorhynchus is a mammal receding to near the grade of birds, and in it behold the bill and web-feet of that order!

For further illustration, it is obvious that, various as may be the lengths of the upper part of the vertebral column in the mammalia, it always consists of the same parts. The giraffe has in its tall neck the same number of bones with the pig, which scarcely appears to have a neck at all.* Man, again, has no tail; but the notion of a much-ridiculed philosopher of the last century is not altogether, as it happens, without foundation, for between the fifth and seventh week of the embryo

* D'Aubenton established the rule, that all the viviparous quadrupeds have seven vertebræ in the neck.

a tail does exist, and in the mature subject the bones of this caudal appendage are found in an undeveloped state in the *os coccygis*. The limbs of all the vertebrate animals are, in like manner, on one plan, however various they may appear. In the hind-leg of a horse, for example, the angle called the hock is the same part which in us forms the heel; and the horse and other quadrupeds, with certain exceptions, walk, in reality, upon what answers to the toes of a human being. In this and many other quadrupeds the fore part of the extremities is shrunk up in a hoof, as the tail of the human being is shrunk up in the bony mass at the bottom of the back. The bat, on the other hand, has these parts largely developed. The membrane, commonly called its wing, is framed chiefly upon bones answering precisely to those of the human hand; its extinct congener, the pterodactyle, had the same membrane extended upon the fore-finger only, which in that animal was prolonged to an extraordinary extent. In the paddles of the whale and other animals of its order, we see the same bones as in the more highly developed extremities of the land mammifers; and even the serpent tribes, which present no external

appearance of such extremities, possess them in reality, but in an undeveloped or rudimental state.

The same law of development presides over the vegetable kingdom. Amongst phanerogamous plants, a certain number of organs appear to be always present, either in a developed or rudimentary state; and those which are rudimentary can be developed by cultivation. The flowers which bear stamens on one stalk and pistils on another, can be caused to produce both, or to become perfect flowers, by having a sufficiency of nourishment supplied to them. So, also, where a special function is required for particular circumstances, nature provided for it, not by a new organ, but by a modification of a common one, which she has effected in development. Thus, for instance, some plants destined to live in arid situations, require to have a store of water which they may slowly absorb. The need is arranged for by a cup-like expansion round the stalk, in which water remains after a shower. Now the *pitcher*, as this is called, is not a new organ, but simply the metamorphosis of a leaf.

These facts clearly shew how all the various organic forms of our world are bound up in one—

how a fundamental unity pervades and embraces them all, collecting them, from the humblest lichen up to the highest mammifer, in one system, the whole creation of which must have depended upon one law or decree of the Almighty, though it did not all come forth at one time. After what we have seen, the idea of a separate exertion for each must appear totally inadmissible. The single fact of abortive or rudimentary organs condemns it; for these, on such a supposition, could be regarded in no other light than as blemishes or blunders—the thing of all others most irreconcilable with that idea of Almighty Perfection which a general view of nature so irresistibly conveys. On the other hand, when the organic creation is admitted to have been effected by a general law, we see nothing in these abortive parts but harmless peculiarities of development, and interesting evidences of the manner in which the Divine Author has been pleased to work.

We have yet to advert to the most interesting class of facts connected with our subject. First surmised by the illustrious Harvey, afterwards illustrated by Hunter in his wondrous collection at the Royal College of Surgeons, finally advanced to mature conclusions by Tiedemann, St. Hilaire,

and Serres, embryotic development is now a science. Its primary positions are—1. that the embryos of all animals are not distinguishably different from each other; and, 2. that those of all animals pass through a series of phases of development, each of which is the type or analogue of the permanent configuration of tribes inferior to it in the scale. With regard to the latter proposition, it is to be remarked that, while it is generally true of the whole forms of animal being, it is more particularly true of departments of the organization, as the nutritive system, the vascular system, the nervous system, &c., each of which is destined for a peculiar degree of development in different groups of animals, according to their needs; and this, I may observe, is so far an explanation of such phenomena as the superiority of the highest mollusks to the lowest vertebrates. Even in man there are some particulars of organization less developed than in certain animals which generally are far inferior. Speaking, however, roundly, it is undoubted that all animals pass in embryo through phases resembling the general as well as the particular characters of those of lower grade. For example, the comatula, a free-swimming star-fish, is, at one stage of its early progress, a crinoid—

that is, a star-fish fixed upon a stalk at the bottom of the sea. It advances from the form of one of the lower to that of one of the higher echinodermata. The animals of its first form were, as we have seen, among the most abundant in the earliest fossiliferous rocks: they began to decline in the new red sandstone era, and they were succeeded in the oolitic age by animals *of the form of the mature comatula.* Thus, too, the insect, standing near the head of the articulated animals, is, in the larva state, an annelid or worm, the annelida being the lowest in the same class. Of the worm, again, it has been observed that it passes through the forms of the polype, helianthois, and arenicola, before attaining its permanent character as an annelid. The higher crustacea, as the crab or lobster, at their escape from the ovum, resemble the perfect animal of the inferior order entomostraca, and pass through all the forms of transition which characterize the intermediate tribes of crustacea. The salmon, a highly organized fish, exhibits, in its early stages, as has been remarked, the gelatinous dorsal cord, the heterocercal tail, and inferior position of the mouth, which mark the mature example of the lower tribes of fishes, the placoids and ganoids. The frog, again, for some time after its birth, is a fish with

external gills, and other organs fitting it for an aquatic life, all of which are changed as it advances to maturity and becomes a land animal. The mammifer only passes through still more stages, according to its higher place in the scale. Nor is man himself exempt from this law. His first form is that which is permanent in the animalcule. His organization gradually passes through conditions generally resembling a fish, a reptile, a bird, and the lower mammalia, before it attains its specific maturity. At one of the last stages of his fœtal career, he exhibits an intermaxillary bone, which is characteristic of the perfect ape; this is suppressed, and he may then be said to take leave of the simial type, and become a true human creature. Even, as we shall see, the varieties of his race are represented in the progressive development of an individual of the highest, before we see the adult Caucasian, the highest point yet attained in the animal scale.

To come to particular points of the organization. The brain of man, which exceeds that of all other animals in complexity of organization and fulness of development, is, at one early period, only "a simple fold of nervous matter, with difficulty distinguishable into three parts, while a little

tail-like prolongation towards the higher parts, and which had been the first to appear, is the only representation of a spinal marrow. Now, in this state it perfectly resembles the brain of an adult fish, thus assuming *in transitu* the form that in the fish is permanent. In a short time, however, the structure is become more complex, the parts more distinct, and the spinal marrow better marked; it is now the brain of a reptile. The change continues; by a singular motion, certain parts (*corpora quadrigemina*) which had hitherto appeared on the upper surface, now pass towards the lower; the former is their permanent situation in fishes and reptiles, the latter in birds and mammalia. This is another advance in the scale, but more remains yet to be done. The complication of the organ increases; cavities termed *ventricles* are formed, which do not exist in fishes, reptiles, or birds; curiously organized parts, such as the corpora striata, are added; it is now the brain of the mammalia. Its last and final change alone seems wanting, that which shall render it the brain of MAN."* And this change in time takes place.

So also with the heart. This organ, in the

* Lord's Popular Physiology.

mammalia, consists of four cavities, but in the reptiles of only three, and in fishes of two only, while in the articulated animals it is merely a prolonged tube. Now in the mammal fœtus, at a certain early stage, the organ has the form of a prolonged tube; and a human being may be said to have then the heart of an insect. Subsequently it is shortened and widened, and becomes divided by a contraction into two parts, a ventricle and an auricle; it is now the heart of a fish. A subdivision of the auricle afterwards makes a triple-chambered form, as in the heart of the reptile tribes; lastly, the ventricle being also subdivided, it becomes a full mammal heart.

It is certainly very remarkable that, corresponding generally to these progressive forms in the development of individuals, has been the succession of animal forms in the course of time. Our earth bore crinoidea before it bore the higher echinodermata. It presented crustacea before it bore fishes, and when fishes came, the first forms were those ganoidal and placoidal types which correspond with the early fœtal condition of higher orders. Afterwards there were reptiles, then mammifers, and finally, as we know, came man. The tendency of all these illus-

trations is to make us look to *development* as the principle which has been immediately concerned in the peopling of this globe, a process extending over a vast space of time, but which is nevertheless connected in character with the briefer process by which an individual being is evoked from a simple germ. What mystery is there here—and how shall I proceed to enunciate the conception which I have ventured to form of what may prove to be its proper solution! It is an idea by no means calculated to impress by its greatness, or to puzzle by its profoundness. It is an idea more marked by simplicity than perhaps any other of those which have explained the great secrets of nature. But in this lies, perhaps, one of its strongest claims to our faith.

The whole train of animated beings, from the simplest and oldest, up to the highest and most recent, are, then, to be regarded as a series of *advances of the principle of development*, which have depended upon external physical circumstances, to which the resulting animals are appropriate. I contemplate the whole phenomena as having been in the first place arranged in the counsels of Divine Wisdom, to take place, not only upon this sphere, but upon all the others in space,

under necessary modifications, and as being carried on, from first to last, here and elsewhere, under immediate favour of the creative will or energy.* The nucleated vesicle, the fundamental form of all organization, we must regard as the meeting-point between the inorganic and the organic—the end of the mineral and beginning of the vegetable and animal kingdoms, which thence start in different directions, but in a general parallelism and analogy. We have already seen that this nucleated vesicle is itself a type of mature and independent being in the infusory animalcules, as well as the starting point of the fœtal progress of every higher individual in creation, both animal and vegetable. We have seen that it is a form of being which there is some reason to believe electric agency will produce—though not perhaps usher into full life—in albumen, one of those component materials of animal bodies, in whose combinations it is believed there is no chemical peculiarity forbidding their being any day

* When I formed this idea, I was not aware of one which seems faintly to foreshadow it—namely, Socrates' doctrine, afterwards dilated on by Plato, that "previous to the existence of the world, and beyond its present limits, there existed certain archetypes, the embodiment (if we may use such a word) of general ideas; and that these archetypes were models, in imitation of which all particular beings were created."

realized in the laboratory. Remembering these things, we are drawn on to the supposition, that the first step in the creation of life upon this planet was *a chemico-electric operation, by which simple germinal vesicles were produced.* This is so much, but what were the next steps? I suggest, as an hypothesis countenanced by much that is ascertained, and likely to be further sanctioned by much that remains to be known, that the first step was *an advance under favour of peculiar conditions, from the simplest forms of being, to the next more complicated, and this through the medium of the ordinary process of generation.*

Unquestionably, what we ordinarily see of nature is calculated to impress a conviction that each species invariably produces its like. But I would here call attention to a remarkable illustration of natural law which has been brought forward by Mr. Babbage, in his *Ninth Bridgewater Treatise.* The reader is requested to suppose himself seated before the calculating machine, and observing it. It is moved by a weight, and there is a wheel which revolves through a small angle round its axis, at short intervals, presenting to his eye successively, a series of numbers engraved on its divided circumference.

Let the figures thus seen be the series, 1, 2, 3, 4, 5, &c., of natural numbers, each of which exceeds its immediate antecedent by unity.

"Now, reader," says Mr. Babbage, "let me ask you how long you will have counted before you are firmly convinced that the engine has been so adjusted, that it will continue, while its motion is maintained, to produce the same series of natural numbers? Some minds are so constituted, that after passing the first hundred terms, they will be satisfied that they are acquainted with the law. After seeing five hundred terms few will doubt, and after the fifty thousandth term the propensity to believe that the succeeding term will be fifty thousand and one, will be almost irresistible. That term *will* be fifty thousand and one; and the same regular succession will continue; the five millionth and the fifty millionth term will still appear in their expected order, and one unbroken chain of natural numbers will pass before your eyes, from *one* up to *one hundred million.*

"True to the vast induction which has been made, the next succeeding term will be one hundred million and one; but the next number presented by the rim of the wheel, instead of being one hundred million and two, is one hundred mil-

lion *ten thousand* and two. The whole series from the commencement being thus,—

	1	
	2	
	3	
	4	
	5	
	. . .	
	. . . .	
	. . . . .	
	. . . . .	
	99,999,999	
	100,000,000	
regularly as far as	100,000,001	
	100,010,002	the law changes.
	100,030,003	
	100,060,004	
	100,100,005	
	100,150,006	
	100,210,007	
	100,280,008	
	. . . . .	
	. . . . .	

"The law which seemed at first to govern this series failed at the hundred million and second term. This term is larger than we expected by

10,000. The next term is larger than was anticipated by 30,000, and the excess of each term above what we had expected forms the following table :—

10,000
30,000
60,000
100,000
150,000
. . . . . .
. . . . . .

being, in fact, the series of *triangular numbers*,* each multiplied by 10,000.

"If we now continue to observe the numbers presented by the wheel, we shall find, that for a hundred, or even for a thousand terms, they continue to follow the new law relating to the triangular numbers; but after watching them for

* The numbers 1, 3, 6, 10, 15, 21, 28, &c. are formed by adding the successive terms of the series of natural numbers thus:

$1 = 1$
$1+2 = 3$
$1+2+3 = 6$
$1+2+3+4 = 10$, &c.

They are called triangular numbers, because a number of points corresponding to any term can always be placed in the form of a triangle; for instance—

2761 terms, we find that this law fails in the case of the 2762nd term.

"If we continue to observe, we shall discover another law then coming into action, which also is dependent, but in a different manner, on triangular numbers. This will continue through about 1430 terms, when a new law is again introduced which extends over about 950 terms, and this, too, like all its predecessors, fails, and gives place to other laws, which appear at different intervals.

"Now it must be observed that *the law that each number presented by the engine is greater by unity than the preceding number*, which law the observer had deduced from an induction of a hundred million instances, *was not the true law that regulated its action*, and that the occurrence of the number 100,010,002 at the 100,000,002nd term was *as necessary a consequence of the original adjustment, and might have been as fully foreknown at the commencement, as was the regular succession of any one of the intermediate numbers to its immediate antecedent.* The same remark applies to the next apparent deviation from the new law, which was founded on an induction of 2761 terms, and also to the succeeding law, with this limitation only—that, whilst their consecutive introduction at various

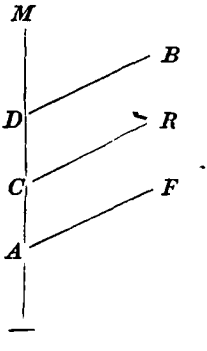
definite intervals, is a necessary consequence of the mechanical structure of the engine, our knowledge of analysis does not enable us to predict the periods themselves at which the more distant laws will be introduced."

It is not difficult to apply the philosophy of this passage to the question under consideration. It must be borne in mind that the gestation of a single organism is the work of but a few days, weeks, or months; but the gestation (so to speak) of a whole creation is a matter probably involving enormous spaces of time. Suppose that an ephemeron, hovering over a pool for its one April day of life, were capable of observing the fry of the frog in the water below. In its aged afternoon, having seen no change upon them for such a long time, it would be little qualified to conceive that the external branchiæ of these creatures were to decay, and be replaced by internal lungs, that feet were to be developed, the tail erased, and the animal then to become a denizen of the land. Precisely such may be our difficulty in conceiving that any of the species which people our earth is capable of advancing by generation to a higher type of being. During the whole time which we call the historical era, the limits of species have been, to

ordinary observation, rigidly adhered to. But the historical era is, we know, only a small portion of the entire age of our globe. We do not know what may have happened during the ages which preceded its commencement, as we do not know what may happen in ages yet in the distant future. All, therefore, that we can properly infer from the apparently invariable production of like by like is, that such is the ordinary procedure of nature in the time immediately passing before our eyes. Mr. Babbage's illustration powerfully suggests that this ordinary procedure may be subordinate to a higher law which only *permits* it for a time, and in proper season interrupts and changes it. We shall soon see some philosophical evidence for this very conclusion.

It has been seen that, in the reproduction of the higher animals, the new being passes through stages in which it is successively fish-like and reptile-like. But the resemblance is not to the adult fish or the adult reptile, but to the fish and reptile at a certain point in their fœtal progress; this holds true with regard to the vascular, nervous, and other systems alike. It seems as if gestation consisted of two distinct and independent

stages—one devoted to the development of the new being through the conditions of the inferior types, or, rather, through the corresponding *first stages of their development;* another perfecting and bringing the new being to a healthy maturity, on the basis of the point of development reached. This may be illustrated by a simple diagram. The fœtus of all the four classes may be supposed to advance in an identical condition to the point A. The fish there diverges and passes along a line apart, and peculiar to itself, to its mature state at F. The reptile, bird, and mammal, go on together to C, where the reptile diverges in like manner, and advances by itself to R. The bird diverges at D, and goes on to B. The mammal then goes forward in a straight line to the highest point of organization at M. This diagram shews only the main ramifications; but the reader must suppose minor ones, representing the subordinate differences of orders, tribes, families, genera, &c., if he wishes to extend his views to the whole varieties of being in the animal kingdom. Limiting ourselves at present to



the outline afforded by this diagram, it is apparent that the only thing required for an advance from one type to another in the generative process is that, for example, the fish embryo should not diverge at A, but go on to C before it diverges, in which case the progeny will be, not a fish, but a reptile. To protract the *straightforward part of the gestation over a small space*—and from species to species the space would be small indeed—is all that is necessary.

To ascertain how this happened is the great problem, but one not to be very readily solved, since our knowledge of nature is far from being clear on such subjects. The analogy, however, which we see existing between the embryotic progress of an individual of the highest class, and the progress of the animal kingdom from the protozoa of the early rocks till man's birth, strongly suggests that, just as a little vesicle, placed in the appropriate receptacle, advances in a few months to be a being of the highest existing organization,—urged on thereto by influences unseen, unknown, inconceivable, yet discernibly natural, and nothing more than natural,—so have the first and simplest of beings advanced upon their several lines of development through unguessed ages, till they at

length became creatures of complicated and extensively adapted structure,—this being similarly produced by an impulse, natural, though perhaps inscrutable, and equally dependent upon associated conditions, though applicable to a world and to centuries of centuries. The point which I here feel for the present to be most doubtful is, whether this universal gestation of nature was, like that of an individual mother, expressly a matter of time, or liable to be affected in that respect by the associated conditions. The question may be left for future consideration, — as also whether certain associated conditions had not some specific influence, apart from the central development, in producing the more external adaptations of the various beings to their respective spheres and ranges of existence.

While we have here nothing but hypothesis to guide us, it is well to keep in view certain facts which seem to point strongly to the laws sought after. We daily see organic development still at work to the production of certain effects only short of a transition from species to species. Sex is fully ascertained to be a matter of development. All beings are, at one stage of the embryotic progress, female; a certain number of them are afterwards *advanced* to be of the more

powerful sex. From this it will be understood that no absolute distinction exists; all such are merely apparent. The ingenious Huber first made us aware of an instance, in a humble department of the animal world, of arrangements being made by the animals themselves for adjusting the law of development to the production of a particular sex. Amongst bees, as amongst several other insect tribes, there is in each community but one true female, the queen bee, the workers being false females or neuters; that is to say, sex is carried on in them to a point intermediate between the female and male, where it is attended by sterility. The preparatory states of the queen bee occupy sixteen days; those of the neuters, twenty; and those of males, twenty-four. Now it is a fact, settled by innumerable observations and experiments, that the bees can so modify a larva, which otherwise would result in a worker, that, when the perfect insect emerges from the pupa, it is found to be a queen or true female. For this purpose they enlarge its cell, make a pyramidal hollow to allow of its assuming a vertical instead of a horizontal position, keep it warmer than other larvæ are kept, and feed it with a peculiar kind of food. From these simple circumstances, leading to a *shortening*

of the embryotic condition, results a creature different in form, and also in dispositions, from what would have otherwise been produced. Some of the organs possessed by the worker are here wanting. We have a creature "destined to enjoy love, to burn with jealousy and anger, to be incited to vengeance, and to pass her time without labour," instead of one "zealous for the good of the community, a defender of the public rights, enjoying an immunity from the stimulus of sexual appetite and the pains of parturition; laborious, industrious, patient, ingenious, skilful; incessantly engaged in the nurture of the young, in collecting honey and pollen, in elaborating wax, in constructing cells and the like!—paying the most respectful and assiduous attention to objects which, had its ovaries been developed, it would have hated and pursued with the most vindictive fury till it had destroyed them!"* All these changes may be produced by a mere modification of the embryotic progress, which it is within the power of the adult animals to effect. But it is important to observe that this modification is different from working a direct change upon the embryo. It is not the different food which effects a metamor-

* Kirby and Spencer.

phosis. All that is done is merely to accelerate the period of the insect's perfection. By the arrangements made and the food given, the embryo becomes sooner fit for being ushered forth in its imago or perfect state. Development may be said to be thus arrested at a particular stage—that early one at which the female sex is complete. In the other circumstances, it is allowed to go on four days longer, and a stage is then reached between the two sexes, which in this species is designed to be the perfect condition of a large portion of the community. Four days more make it a perfect male. It may be observed that there is, from the period of oviposition, a destined distinction between the sexes of the young bees. The queen lays the whole of the eggs which are designed to become workers, before she begins to lay those which become males. But probably the condition of her reproductive system governs the matter of sex, for it is remarked that when her impregnation is delayed beyond the twenty-eighth day of her entire existence, she lays only eggs which become males.

We have here, it will be admitted, a most remarkable illustration of the principle of development, although in an operation limited to the pro-

duction of sex only. Let it not be said that the phenomena concerned in the generation of bees may be very different from those concerned in the reproduction of the higher animals. There is a unity throughout nature which makes the one case an instructive reflection of the other.

We shall now see an instance of development operating within the production of what approaches to the character of variety of species. It is fully established that a human family, tribe, or nation, is liable, in the course of generations, to be either advanced from a mean form to a higher one, or degraded from a higher to a lower, by the influence of the physical conditions in which it lives. The coarse features, and other structural peculiarities of the negro race only continue while these people live amidst the circumstances usually associated with barbarism. In a more temperate clime, and higher social state, the face and figure become greatly refined. The few African nations which possess any civilization exhibit forms approaching the European; and when the same people in the United States of America have enjoyed a within-door life for several generations, they assimilate to the whites amongst whom they live. On the other hand, there are authentic instances of a people

originally well-formed and good-looking, being brought, by imperfect diet and a variety of physical hardships, to a meaner form. It is remarkable that prominence of the jaws, a recession and diminution of the cranium, and an elongation and attenuation of the limbs, are peculiarities always produced by these miserable conditions, for they indicate an unequivocal retrogression towards the type of the lower animals. Thus we see nature alike willing to go back and to go forward. Both effects are simply the result of the operation of the law of development in the generative system. Give good conditions, it advances; bad ones, it recedes. Now, perhaps, it is only because there is no longer a possibility, in the higher types of being, of giving sufficiently favourable conditions to carry on species to species, that we see the operation of the law so far limited.

Let us trace this law also in the production of certain classes of monstrosities. A human fœtus is often left with one of the most important parts of its frame imperfectly developed: the heart, for instance, goes no farther than the three-chambered form, so that it is the heart of a reptile. There are even instances of this organ being left in the two-chambered or fish-form. Such defects are

the result of nothing more than a failure of the power of development in the system of the mother, occasioned by weak health or misery, and bearing with force upon that sub-stage of the gestation at which the perfecting of the heart to its right form ought properly to have taken place. Here we have apparently a realization of the converse of those conditions which carry on species to species, so far, at least, as one organ is concerned. Seeing a complete specific retrogression in this one point, how easy it is to suppose an access of favourable conditions sufficient to reverse the phenomenon, and make a fish mother develop a reptile heart, or a reptile mother develop a mammal one. It is no great boldness to surmise that a super-adequacy in the measure of this under-adequacy (and the one thing seems as natural an occurrence as the other) would suffice to accomplish this purpose, carrying forward the last of the reptilia into—we shall say hypothetically—the first of the mammalia.

Perhaps even the transition from species to species does still take place in some of the obscurer fields of creation, or under extraordinary casualties, though science professes to have no such facts on record. It is here to be remarked, that such facts

might often happen, and yet no record be taken of them, for so strong is the prepossession for the doctrine of invariable like-production, that such circumstances, on occurring, would be almost sure to be explained away on some other supposition, or, if presented, would be disbelieved and neglected. Science, therefore, has no such facts, for the same reason that some small sects are said to have no discreditable members—namely, that they do not receive such persons, and extrude all who begin to verge upon the character. There is, however, one direct case of a translation of species, which has been presented with a respectable amount of authority.* It appears that, when oats sown at midsummer are kept cropped down, so as to be prevented from shooting into ear, during summer and autumn, and allowed to remain over the winter, a thin crop of rye is the harvest presented at the close of the ensuing summer. This experiment has been tried repeatedly, with but one result; invariably the *secale cereale* is the crop reaped where the *avena sativa*, a recognised different species, was sown. Now it will not satisfy a strict inquirer to be told that the

* See an article by Dr. Weissenborn, in the New Series of "Magazine of Natural History," vol. i. p. 574. See also the Gardener's Chronicle, August and November, 1844.

seeds of the rye were latent in the ground, and only superseded the dead product of the oats; for if any such fact were in the case, why should the usurping grain be always rye? Perhaps those curious facts which have been stated with regard to forests of one kind of trees, when burnt down, being succeeded (without planting) by other kinds, may yet be found most explicable, as this is, upon the hypothesis of a transmutation of species which takes place under certain favouring conditions, now apparently of comparatively rare occurrence. The case of the oats is the more valuable, as bearing upon the suggestion as to a protraction of the gestation at a particular part of its course. Here, the generative process is, by the simple mode of cropping down, kept up for a whole year beyond its usual term. The type is thus allowed to advance, and what was oats becomes rye.

It may be said that perhaps the oats and rye are not, in reality, of different species, but only varieties of one, liable to return to, or melt into, each other in proper circumstances. Such a unity was established, some years ago, in the case of four plants apparently different in species—namely, the cowslip, primrose, oxslip, and polyanthus. And it is now believed by many botanists, that other

plants, heretofore supposed to be specifically different, will be found, in like manner, to be only variations of one type, consequent upon peculiarity of external conditions. Admit this, and what does it lead to, but to a conclusion favourable to the present argument? For, if differences so great as to have hitherto been held specific, and in the case of the oats and rye even generic, are thus susceptible of reduction or intercommunion by certain changes of conditions, what more than such changes of conditions, perhaps only a little greater in degree, can be supposed to be necessary in order to make one clearly peculiar type of being pass into another? Is it not legitimate, in such a case, to suppose that we should have the phenomenon of transmutation as strongly and decidedly exemplified as the greatest sceptics could desire, if we only had plants and animals placed in circumstances bearing upon their generative system with the requisite degree of force? It is well here to recollect that the terms, species, genus, etc., are merely human conceptions to indicate apparent differences, and are nowhere seen to be pronounced by nature herself. Nor can the ablest zoologists or phytologists agree on what ought to be held as constituting a distinct species. So that when they argue against

transmutation of species, they confessedly are arguing against a phenomenon which can have no precise character in their minds. Unquestionably, *many intervals of form, which botanists have been accustomed to regard as distinctions of species, have been passed over.* Who, for example, could detect in the garden-cabbage, with its stout fleshy stem and large succulent leaves gathered into a *heart* several feet in circumference, the wild kale of the sea-shore, which trails among the shingle with a tough slender stem and small glaucous leaf? Yet is the maritime weed the progenitor of the garden vegetable. Or who could detect the parent sloe in our delicious purple and yellow plums; or say that the sour crab of our hedges was the original of the numberless varieties of apples now cultivated by gardeners? These transformations, like that of the primrose into the polyanthus, is known to be merely the effect of changed conditions. The sole question, then, appears to be, what bounds are we to set to a mutability which, even in the present comparatively settled times of nature, is seen to be so great? What more could be required, at the era of the first formation of dry land, than that aquatic plants should have extended their kind into the new ground, in order to clothe the sun-lit earth with

some of its earliest vegetable forms? Still, it may be acknowledged, these mutations are perhaps only such as naturalists have been accustomed to regard as *varieties*, and from species to species may be an interval of a more decided kind, such as we do not usually see taking place, and which, therefore, we have no right to say ever took place through merely natural means. Admit the decisive character of this presumed interval, and we are not necessarily to conclude that it is insuperable through natural means. That such transitions *have taken place* geology testifies; that when they were taking place, ordinary physical operations of all kinds were going on as now, is equally certain. So far from there being any improbability that the causes were natural, there is no proof whatever in nature that they were otherwise; all analogy goes to the opposite determination. We are, then, bound to seek for these causes in nature, and to use our best endeavours to find them. It may not be possible all at once to penetrate their character, and set them forth to the satisfaction of intelligent minds. But if the general likelihood be admitted, and a variety of facts brought forward showing the requisite causes operating in a certain degree of force even at the present day,—there will certainly

be strong grounds established for the hypothesis now submitted respecting this most interesting question.

The idea, then, which I form of the progress of organic life upon our earth—and the hypothesis is applicable to all similar theatres of vital being—is, *that the simplest and most primitive type, under a law to which that of like-production is subordinate, gave birth to the type next above it, that this again produced the next higher, and so on to the very highest,* the stages of advance being in all cases very small —namely, from one species only to another; so that the phenomenon has always been of a simple and modest character. Thus, the production of new forms, as shewn in the pages of the geological record, has never been anything more than a new stage of progress in gestation, an event as simply natural, and attended as little by any circumstances of a wonderful or startling kind, as the silent advance of an ordinary mother from one week to another of her pregnancy. Yet, be it remembered, the whole phenomena are, in another point of view, wonders of the highest kind, in as far as they are direct effects of an Almighty will, which had provided beforehand that everything should be very good.

It would obviously be of great importance for the illustration of this hypothesis, if we possessed a classification of the animal kingdom which, showing the ascertained affinities of the various families, should enable us to trace the presumed genetic connexions. No such classification exists; but the late Dr. Fletcher, in his Rudiments of Physiology, introduced a scale of families or orders, by which, he thought, we might ascend from the most abject forms to the most exalted; "assuming," he said, "as the criterion of advancement, an increase in the number and extent of the manifestations of life, or of the relations which an organized being bears to the external world." He did not present this scale as anything more than a rough approximation to the actual order, for, as he remarked, setting aside all other difficulties, "it is not always easy to determine the superiority, with respect to its rank as an organized being, of one tribe, whether of plants or of animals, compared with another; since, while the one certainly excels the other perhaps in some particulars, it may in an equal degree fall short of it in others, so that the balance, in any individual instance of comparison, is not always easily settled." One objection to the scale will strike naturalists at the first glance, the placing

of the articulata in a line running on from the mollusca. These two sub-kingdoms would now undoubtedly be placed side by side, with the superior mollusca rising above the highest articulata. It will yet also be found that the mammalia advance in several lines, requiring a parallel instead of a continuous arrangement, and placing several orders side by side which are here seen in succession. Nevertheless, the scale formed by Dr. Fletcher is the best within reach, and I am induced to bring it forwards, not only as a suggestion of family affinities, but for the further purpose of showing the remarkable parallelism which exists between this scheme of progressive animalization, and the origin of the various families in the successive eras denoted by rock formations. There is added in another column a view, likewise from Dr. Fletcher's work, of the further parallelism between these progresses and that of a principal organ in the human embryo.* There is this to be said in favour of the

* "It is a fact of the highest interest and moment that, as the brain of every tribe of animals appears to pass, during its development, in succession through the types of all those below it, so the brain of man passes through the types of those of every tribe in the creation. It represents, accordingly, before the second month of utero-gestation, that of an avertebrated animal; at the second month, that of an osseous fish; at the third, that of a turtle; at the fourth, that of a bird; at the fifth, that of one of the rodentia;

scale and the view of the progress of the brain in embryo given by this author, that he prepared them with no view to such a hypothesis as it is here my object to unfold. Had such a consideration not been paramount, it would have been easily possible now to make out a scale at once more satisfactory to the naturalist, and more perfectly accordant with the revelations of geology. As it is, I have only taken leave to make two alterations, the propriety of which no living zoologist will dispute, namely, to put back the pteropoda from before the gasteropoda, and to put forward the ruminantia from behind the pachydermata to a more appropriate place. The pteropoda must be earlier in order than the gasteropoda, for it is an embryotic form of the higher classes of its sub-

at the sixth, that of one of the ruminantia; at the seventh, that of one of the digitigrada; at the eighth, that of one of the quadrumana; till at length, at the ninth, it compasses the brain of Man! It is hardly necessary to say, that all this is only an approximation to the truth; since neither is the brain of all osseous fishes, of all turtles, of all birds, nor of all the species of any one of the above order of mammals, by any means precisely the same, nor does the brain of the human fœtus at any time precisely resemble, perhaps, that of any individual whatever among the lower animals. Nevertheless, it may be said to represent, at each of the above-mentioned periods, the aggregate, as it were, of the brains of each of the tribes stated."—*Fletcher's Rudiments of Physiology.*

kingdom. The pachydermata, again, may with equal propriety be placed before the ruminantia, on the strength of comparative organization as admitted by naturalists.*

* In the table, the orders of the inferior mammalia of the tertiary formations are arranged, generally speaking, in the order in which they occur in the successive sub-groups of the strata as found in Europe: thus, the pachydermata, rodentia, and marsupialia, occur in the eocene; the digitigrada and plantigrada in the miocene. This, however, is the part of the table most likely to require re-arrangement, both with regard to the occurrence of orders in strata, and the places of these in classification. I have no doubt that a more correct arrangement would tell more favourably for an analogy with the third column.

SCALE OF ANIMAL KINGDOM.				ORDER OF ANIMALS IN	
Invertebrata					
1	Infusoria			*Traces of Infusoria* (?)	
2	Polypi			Polypiaria	
5	Echinodermata			Echinodermata	
Mollusca. 7	Brachiopoda	*Articulata.* 15—20	Crustacea	Brachiopoda	Crustacea
9	Pteropoda			Pteropoda	
10	Gasteropoda	12—14	Annelides	Gasteropoda	Annelides.
11	Cephalopoda			Cephalopoda	
Vertebrata					
32—36	Fishes			*Remains of Fishes*	
				Fishes of low type; heterocercal; allied to crustacea	
				Sauroid Fishes	
37	Batrachia (frogs, &c.)			Batrachia	
39	Sauria (lizards, &c.)			Sauria	
40	Chelonia (tortoises)			Chelonia	
41—46	Birds			*Footsteps of Birds*	
47	Cetacea (dolphins, whales, &c.)			*Bones of a Cetaceous Animal*	
				Bones of a Marsupial	
48	Pachydermata (tapirs, &c.)			Pachydermata	
49	Edentata (sloths)			Edentata	
50	Rodentia (squirrels, hare, &c.)			Rodentia	
51	Marsupialia (opossums, &c.)			Marsupialia	
52	Ruminantia (oxen, stag, &c.)			Ruminantia	
53	Amphibia (seals)				
54	Digitigrada (dog, cat, &c.)			Digitigrada	
55	Plantigrada (bear, &c.)			Plantigrada	
56	Insectivora (shrew, &c.)			Insectivora	
57	Cheiroptera (bats)			Cheiroptera	
58	Quadrumana (apes)			Quadrumana	
59	Bimana (man)			Bimana	

ASCENDING SERIES OF ROCKS.	FŒTAL HUMAN BRAIN RESEMBLES, IN
1 Gneiss and Mica Slate system	1st month, typically, that of an avertebrated animal;
2 Clay Slate system	
3 Silurian system	
4 Old Red Sandstone	2nd month, that of a fish;
5 Carboniferous formation	
6 New Red Sandstone	3rd month, that of a turtle; 4th month, that of a bird;
7 Oolite	
8 Chalk	
9 Tertiary	5th month, that of a rodent; 6th month, that of a ruminant; 7th month, that of a digitigrade animal;
10 Superficial deposits	8th month, that of the quadrumana; 9th month, attains full human character.

The reader has seen physical conditions referred to, as to be presumed to have in some way governed the progress of the development of the zoological series. This language may seem vague, and, it may be asked,—can any particular physical condition be adduced as likely to have affected development? It may be answered, that air and light are possibly amongst the principal agencies of this kind which operated in educing the various forms of being. Light is found to be essential to the development of the individual embryo. When tadpoles were placed by Dr. Milne Edwards in a perforated box, and that box sunk in the Seine, light being the only condition thus abstracted, they grew to a great size in their original form, but did not pass through the usual metamorphose which brings them to their mature state as frogs. The proteus, an animal of the frog kind, which lives in subterranean waters where there is no light, and which never changes the branchiæ for lungs, looks as if the development of that part of its organization had been arrested from a similar cause. When, in connexion with these facts, we learn that human mothers living in dark and close cells under ground,—that is to say, with an inadequate provision of air and light,—are

found to produce an unusual proportion of defective children,* we can appreciate the important effects of both these physical conditions in ordinary reproduction. Now there is nothing to forbid the supposition that the earth has been at different stages of its career under different conditions, as to both air and light. On the contrary, we have seen reason for supposing that the proportion of carbonic acid gas (the element fatal to animal life) was larger before and at the time of the carboniferous formation than afterwards. We have also seen that astronomers regard the zodiacal light as a residuum of matter enveloping the sun, and which was probably at one time denser than it is now. Here we have the indications of causes for a progress in the purification of the atmosphere and in the diffusion of light during the earlier ages of the earth's history, with which the progress of organic life may have been conformable. An accession to the proportion of oxygen, and the effulgence of the central luminary, may have been the immediate prompting cause of all those advances

* Some poor people having taken up their abode in the cells under the fortifications of Lisle, the proportion of defective infants produced by them became so great, that it was deemed necessary to issue an order commanding these cells to be shut up.

from species to species which we have seen, upon other grounds, to be necessarily supposed as having taken place. And causes of the like nature may well be supposed to operate on other spheres of being, as well as on this. I do not indeed present these ideas as furnishing the true explanation of the progress of organic creation; they are merely thrown out as hints towards the formation of a just hypothesis, the completion of which is only to be looked for when some considerable advances shall have been made in the amount and character of our stock of knowledge.

Early in this century, M. Lamarck, a naturalist of the highest character, suggested a hypothesis of organic progress which has incurred much ridicule, and scarcely ever had a single defender. He surmised, and endeavoured, with a great deal of ingenuity, to prove, that one being advanced in the course of generations to another, in consequence merely of its experience of wants calling for the exercise of its faculties in a particular direction, by which exercise new developments of organs took place, ending in variations sufficient to constitute a new species. Thus he thought that a bird would be driven by necessity to seek its food in the water, and that, in its efforts to swim, the

outstretching of its claws would lead to the expansion of the intermediate membranes, and it would thus become web-footed. It is hardly necessary to remark how inadequate does this view of Lamarck appear to account for the rise of the organic kingdoms. If he had suggested a law of development for advancing the fundamental or internal organization in a succession of stages like those of the individual ovum of the highest animal, and pointed to some abnormal and not as yet understood tendency in organic beings to give rise, *through the medium of generation*, to modifications of external structure fitting the progeny for new conditions; and if, to these ideas, he had added a more explicit acknowledgment of the whole being the evolution of a divine will, which was present in it all; he would, in my opinion, have come much nearer to fact, and obtained a more patient hearing from mankind.

But the idea that any of the lower animals have been concerned in any way with the origin of man —is not this degrading? Degrading is a term expressive of a notion of the human mind, and the human mind is liable to prejudices which prevent its notions from being invariably correct. Were we acquainted for the first time with the circum-

stances attending the production of an individual of our race, we might equally think them degrading, and be eager to deny them, and exclude them from the admitted truths of nature. Knowing this fact familiarly and beyond contradiction, a healthy and natural mind finds no difficulty in regarding it complacently. Creative Providence has been pleased to order that it should be so, and it must therefore be submitted to. The present hypothesis as to the progress of organic creation, if we become satisfied that it is in the main the reflection of a great truth, ought to be received precisely in this spirit. Say it has pleased Providence to arrange that one type of being should give birth to another, until the second highest gave birth to man, who is the very highest; be it so; it is our part to admire and to submit. The very faintest notion of there being anything ridiculous or degrading in the theory—how absurd does it appear when we remember that every individual amongst us actually passes through the characters of the insect, the fish, and reptile, (to speak nothing of others,) before he is permitted to breathe the breath of life! But such notions are mere emanations of false pride and ignorant prejudice. He who entertains them little reflects that they, in reality,

involve a contempt for the works and ways of God. For it may be asked, if He, as appears, has chosen to employ inferior organisms as a generative medium for the production of higher ones, even including ourselves, what right have we, his humble creatures, to find fault? There is, also, in this prejudice, an element of unkindliness towards the lower animals, which is utterly out of place. These creatures are all of them part products of the Divine Conception, as well as ourselves. All of them display wondrous evidences of his wisdom and benevolence. All of them have had assigned to them by their Great Father a part in the drama of the world, as well as ourselves. Why should they be held in such contempt? It is to be feared that with this proud prejudice is connected much of that inhumanity which is shewn to the inferior animals, and which tends to degrade man himself below them. Let us regard them in a right spirit, as parts of a grand plan which only approaches its perfection in ourselves, and we shall see no degradation in the idea of a genetic connexion with them, but, on the contrary, reason incontestable for treating them in the manner which we already feel that a high morality demands.

THE HYPOTHESIS CONSIDERED

IN CONNEXION WITH

THE AFFINITIES AND GEOGRAPHICAL DISTRIBUTION OF ANIMALS.

In the preceding chapters allusion has been repeatedly made to the gradation observed in the forms of the various beings composing the organic kingdoms, from the simple infusoria and fuci up to the highest mammals and dicotyledons. Upon such a gradation the whole of this theory depends, and it therefore is desirable that a view of it should be given in the present place, however briefly.

In the words of Mr. Rymer Jones, "from whatever form or race of animals we advance towards the next succeeding it in the great scale of Nature, we find ourselves insensibly led on by such gentle gradations, as to make the transition from class to

class almost imperceptible."* It is indeed remarked, that this scale is not quite regular or uninterrupted. But this is only an objection to the ignorant idea hitherto entertained respecting what is commonly called the chain of being. It is found, on actual and careful inspection, to be plural throughout, and to be also branching. It was no wonder, of course, that all the families composing it could not be forced into one series, or that the outer extremities of the various ramifications did not shade into any part of the trunk.

I propose here to make an attempt to show the affinities traceable in various parts of the animal kingdom, as considering these to be essential to the hypothesis of genetic connexions, or of the ancestry of animals. Let it first be understood that the adventure is undertaken in the midst of great difficulties, arising partly from the imperfect knowledge we have of nature, and partly from the extinction of various families in the course of the geological ages. Nor do resemblances in different families always give us light on this subject, but often serve rather as a perplexity, seeing that these sometimes are only indications of parity in grade of organization, instead of being marks of true affinity.

* Outline of the Animal Kingdom, p. 537.

I nevertheless trust to establish strong grounds for concluding that the various families run in certain lines genetically connected, and that they have come into existence in succession, conformably to the coming into existence of fields of life suitable for them, and to which they bear a reference in their organization. I trust to be able to show that these relations, which have been the subject of so much admiration as proof of creative design, are even entitled to a greater share of worshipful consideration, since they must be presumed to have resulted from no special niceties of workmanship on the part of their Divine Author, as they are usually regarded in the treatises of natural theology, but from laws of infallible harmony of operation, in the idea of which we have a far higher view of deity. If the suggested affiliation of the animal families be admitted, it will necessarily follow that vegetables have had an exactly similar history; and to their genealogies, therefore, I shall not refer in detail.

Two lines are clearly distinguishable, and they alone are of any considerable importance. One is characterized by a symmetricality of structure depending on the arrangement of the nervous system; the other is of unsymmetrical organization, depending on the importance of the nutri-

tive system. The second does not advance to nearly so high a point in complexity of organization as the first, and in intelligence it is, generally speaking, greatly inferior. Its families are almost wholly aquatic. The first line comprehends, in descending order, the chief sub-kingdom, VERTEBRATA, the ARTICULATA, and certain classes in the comparatively obscure sub-kingdoms below the last. The second line is composed of the MOLLUSCA, based in like manner upon certain inferior classes.

With regard to other lines, it may be enough at present to indicate one as passing from the humble form of the *sponges* through the great polypiferous class, and another as composed of the *Entozoa*, or internal parasites, a class especially remarkable on the present occasion, seeing that they cannot be presumed to have come into existence till after the creation of the higher animals on which they depend for lodging and subsistence. The varieties of the entozoa are wonderfully great, and they extend from the humblest imaginable grade of organization up to one (cœlelmintha), of which the higher forms are nearly on a par with the lowest of the Articulata, which they much resemble.

Returning to the two grand lines—and first adverting to the second, which comprehends

Cuvier's great sub-kingdom, the MOLLUSCA,—we find its starting point in the infusorial animalcules, the *Monads*, or Vibriones, the *Polygastria*, and the *Rotifera;* a succession of microscopic, but gradually ascending forms; which become developed in this order in a common infusion of vegetable or animal matter. This line then proceeds by a series of easily recognisable steps to the *Bryozoa*, which again verge upon the Ascidians in the molluscous order of the *Tunicata*. That such is a true genetic line, is indicated by close affinity of forms; but such is not the only method of investigating the pedigrees of animals. A second and surer method is to observe the series of forms which the various animals go through in embryo, as these invariably represent the animals lower in organization, and which, according to our hypothesis, were the progenitors of those forming the subject of inquiry. Taking this latter plan, we feel that we are receiving additional light respecting the pedigree of the Mollusca, when we learn that, "at their coming forth from the egg, they swim about for some time in a condition which can scarcely be termed animal; for there is not even a mouth leading to an internal cavity, nor are there any other organs of locomotion than the cilia, the action of which is involuntary."

This description clearly points to the infusorial form.

Amongst the classes of the Mollusca is one very abundant in individuals, and named *Pteropoda*, because enabled to swim by means of two broad fleshy expansions resembling wings. Next above them are the *Gasteropoda*,* which derive their appellation also from their mode of locomotion, namely contractions of the fleshy skin on the lower part of their bodies. Professor Edward Forbes says† with respect to the *Gasteropoda*, that "they all commence life under the same form, both of shell and animal; namely, a very simple spiral, helicoid shell, and an animal furnished with two ciliated wings or lobes, by which it can swim freely through the fluid in which it is contained. At this stage of the animal's existence it corresponds to the permanent state of a Pteropod, and the form is alike, whether it be afterwards a shelled or a shell-less species." It is thus proved that the Gasteropods are, upon an admission of our hypothesis, descended from, or an advance upon the Pteropods. The obviously highest

* "The transition from Pteropoda to Gasteropoda is obviously made by the Phillerоë, the Glaucus, the Carinaria, and the Firola, all floating pelagic genera remarkable for the delicacy of their tissues, &c."—*Owen*, p. 293.

† Edin. Phil. Journal, xxxvi. 326.

class of the Mollusca are the *Cephalopoda*. Of them Mr. Forbes says, "The nucleus of their shells is a spiral univalve, similar in form to the undeveloped shells above alluded to; and it is yet to be seen whether all Cephalopoda do not commence their existence under a spiral-shelled pteropodous form." John Hunter remarked the elevation of the Cephalopods above the Gasteropods, as indicated by "the high development of the cerebral ganglions and the protection afforded them by a cartilaginous cranium."* The nautilus he considered as a link connecting these two classes.

It thus appears that the Pteropoda, Gasteropoda, and Cephalopoda, are upon one genealogical line. The probable connexion from these down to the Tunicata through the intermediate orders of *Lamellibranchiata* and *Brachiopoda*, must be left for future investigation: it is meanwhile supported by a remark of Mr. Forbes, that the larva of the pteropod will yet most likely be found to resemble an ascidian polype. In here speaking of a genealogical line, it is to be kept in mind that each class ascends to characters superior to the lowest forms of the next above it; a fact which entirely ceases to be a puzzle when we come

* Catalogue, Royal Coll. Surgeons.

to regard the classes as *branches* arising in succession from one trunk line of development. There is no form of the molluscous sub-kingdom which stands above the cephalopoda in point of organization. In the rudiment which they possess of an internal skeleton, and in the symmetry of the vital organs, they make a remarkable approach to the Vertebrate sub-kingdom, and Professor Owen has pointed out their tentacula as appearing in a reduced form in the eight free filaments which surround the mouths of the cyclostomous fishes.* It seems by no means clear that a connexion here exists. It is more likely that the Cephalopods form the extremity of the line under notice, which has in them attained the utmost exaltation of which its general character was capable, or which external physical conditions permitted, the degree reached being an approximation to vertebrate peculiarities. The general character of this line is centered in the nutritive system. A mollusk is essentially an eating animal. Its stomach is the principal organ kept in view, and to it every other department of the organization is subordinate. Hence arises that non-symmetrical arrangement of the nervous system which has given them a new name (HETERO-

* Todd's Cyclopedia, article Cephalopoda.

GANGLIATA) amongst modern naturalists. This general character is not clearly seen passing any higher upwards in the animal kingdom, for, in the Vertebrata, the nervous system is evidently what determines the structure, and that to which everything else is subordinate. I therefore regard the Mollusca as, most probably, an independent line, which reaches its ultimatum in the Cephalopoda, as the vertebrated line does in the mammalia, and there terminates. As a line, in which the inferior object of nutrition takes a lead, is it not somewhat over-estimated by modern physiologists? The organization even of the Cephalopoda, high as it is, is, after all, devoted only to the service of a voracious stomach. Are not, then, these destructives of the primeval seas treated somewhat more respectfully, by geologists especially, than they deserve to be?

The grand line of animalization—that which is crowned by the mammal tribes—is (as far as traceable backwards) first conducted through the great class of the *Polypi*, to the *Echinodermata*, a class which, like the former, we have seen make a conspicuous appearance as fossils in the earlier rocks. It will be remembered that the crinoid, an early echinodermatous form, is

an animal composed of a stomach and surrounding tentacles, placed upon the top of a stalk growing from the bottom of the sea, the whole body, arms, and stalk being composed of numerous little calcareous plates connected by gelatinous substance. This part of the animal scale has been beautifully illustrated by Professor Edward Forbes, in his work on Star-fishes, in which we see the fancy and taste of the man of genius united with the fruits of industrious scientific observation. It would at first sight appear as if there could be no affinity between the many-armed and sessile crinoid and the long cylindrical figure of the *fistularidæ;* but such a connexion is made quite distinct when the intermediate forms of *asteridæ, echinidæ,* and *holothuriadæ* are placed in succession. The stalk of the crinoid is an embryotic peculiarity of the free-swimming echinoderm, such as comatula, which Mr. Thomson found, in its young state, growing at the bottom of the sea in the Cove of Cork. The rays of this kind of animal are, in the genera adjoining to it, closed in upon the body, so as to give the whole a globular shape. This is afterwards seen elongated in the holothuria, and thus we come to the worm-like fistularidæ.

Here the reader's attention may be called to one

or two remarks of a general nature. It is particularly worthy of notice that the transition from form to form in the lower sub-kingdoms is much more rapid than it afterwards becomes,—a circumstance precisely in accordance with what we find in the history of an embryo of the higher classes, where, to use the words of Professor Owen, "the changes succeed each other with a rapidity proportionate to the proximity of the ovum to the commencement of its development."* Hence, as was remarked in an earlier chapter, we only see what might have been expected, when we find early rocks charged with fossils reaching up to mollusks and crustaceans. It should also be observed how the breaking short of a line of development in the Entozoa, and the unavoidable conclusion as to the recentness of that development, harmonize with the views of those who hold that primitive developments of certain lowly forms of being do still take place in the theatre of nature.

We have seen a line of approximation from the lowest sub-kingdom to the Articulata through the medium of the fistularidæ. The *Annelidans*, with which the fistularidæ form an obvious junction, are apt at first to appear a perplexing class, for, while there are many reasons for placing them at the

* Article *Acrita*, in Todd's Cyclopedia.

bottom of the Articulata, they also connect beyond doubt with a low grade of fishes. In reality, this is only a difficulty while we adhere to the preconceived idea that the uppermost forms of one sub-kingdom must necessarily form the sole point of junction with the lowest of the next.

Seeking for the light afforded by development, with regard to the genealogies of the articulate classes, we find that a member of the great class *Insecta* emerges from the egg in the form of an annelidan (the larva), external limbs being either wanting or very slightly developed. Where we see the larva possessed of limbs, we must presume its representing the myriapods. There is therefore the best reason to believe that the *Annelides*, *Myriapoda*, and *Insecta*, form parts of one line, in that order of succession. The *Crustacea* and *Arachnida* are collateral classes, apparently branching from the same vermiform root, and each having, like the myriapods and insects, a distinct apex in its own highest forms, the latter, however, being the highest in point of nervous organization.

The lowest sub-divisions of the animal kingdom (Acrita and Nematoneura of modern English zoologists; Radiata of Cuvier) are wholly aquatic. It is now to be observed, that the lowest forms of all the classes in the higher sub-kingdoms are

likewise inhabitants of the water. Naturalists remark, that "in reviewing the series of animals which compose each division [of the kingdom], we constantly find that the simplest structures and modes of progression are those belonging to the aquatic tribes:" these always "compose the lowest link of the ascending chain."* The explanation is, that *the ocean has all along formed the medium in which the grand or main line of animal life was conducted through its successive stages of development, while only branches or lateral extensions went off towards the land.* Here, it appears to me, we have the first hint of a principle by which many difficult problems in animal classification may be solved. It is in the Mollusca and Articulata that the first examples of land genera occur. In the former we first find these arising from the gasteropodous type, in the unpretending forms of the *Snails.* And it may be remarked of all the three highest or encephalous classes of mollusca, that, in their highest families, they acquire organs for atmospheric respiration; and thus become fitted to move upon the surface of the ocean; a step intermediate to that of passing to terrestrial life. In the Articulata, there is a greater number of terrestrial branchings. First, we see the Anne-

* Roget's Bridgewater Treatise, i. 482.

lides sending off *Naides* to burrow in the sands of the sea-shores; and *Arenicolæ* (earth-worms) to assume a similar habitat on land; the Naides being, it may be remarked, an acknowledgedly intermediate form. We likewise see the Annelides modified by a development of lungs, a diminution of the annulose sections, and a concentration of the nervous system, into the terrestrial class of *Myriapoda*, (millepedes and centipedes,) fitted to live beneath stones and under the bark of trees. From the same root spring the varied class of *Insects*, some of which continue the same obscure habits, while the greater number, by virtue of a delicate membraneous organization developed from the respiratory system, are enabled to fill the air itself with life and beauty. Turning to the *Crustacea*, we find a similar rise, in that class, of littoral and land-living families from the marine. The *Arachnida*, too, which are mainly land animals, begin with aquatic families. Now, in all these cases, *there is a progressive development or improvement of structure as we advance from the marine families to those of the land.* And it is important to remark, that the mollusca and articulata of the early rock systems are exclusively of the marine families; so that many ages must have elapsed before the divisions of even these sub-

kingdoms were completed. Do we not here see a most natural and intelligible course of procedure? At first, the earth presented only seas and sea-animals. Afterwards shores were formed, and animals fitted for living on such a field were produced by an advance of development from certain of the marine tribes. In time, there was dry land and vegetation, and then the shore animals gave birth to families fitted for that superior theatre of existence. Mysterious connexion between physical circumstances and organic development! shall we ever be able to penetrate its character or trace its mode of action? Let us not despair.

We have now reached the highest of the sub-kingdoms, the VERTEBRATA; and this we enter by the class *Pisces*, all of them aquatic. In the present state of the classification of this important portion of the animal kingdom, I incur little risk with true naturalists, when I profess to give no clear views of the genealogical lines which may be supposed to pass through it. All that can now be advanced with any confidence is, that from the red-blooded annelides there is a gradual transition into the *Cyclostoma*, a family of humble worm-like form, possessing a very slight vertebral column and suctorial mouth, the myxine and amphioxus being the lowest known genera, and the lampreys only a

little farther advanced. We have no reason, however, to be assured that these fishes were the first of their class, in point of time. Another line has been indicated as starting in the early era of the Upper Silurians or Old Red Sandstone with those crustacean-like forms, cephalaspis, coccosteus, etc., which, from their heterocercal tails and the non-discovery of any internal skeleton, appear to have also been of comparatively low organization. They go on to what has been called the sauroid family in the carbonigenous era, namely, ganoid fishes, presenting in their teeth and scales affinities to the saurian order of the reptiles. M. Agassiz, besides indicating some such line of fish genealogy, implies, likewise, distinct pedigrees for his other three orders; but I do not feel bound to follow him in so obscure a walk since his classification is not yet approved as a natural one.

Some difficulty has been experienced by many in the reception of the development theory, in consequence of this early appearance of reptile peculiarities. The common form of expression for this difficulty is, that the early fishes, so far from being simple in structure, betray affinities to the next highest class of vertebrata, and thus appear to start at a high point, and afterwards sink to a low one. As far as any such difficulty can have been

really felt, it must have arisen from a confusion of mind as to what is entitled to be called early. The sauroid family appears early in comparison with the whole geological chronology, but so does Joseph appear early in history, as well as Abraham, and yet we know that the one was great grandson to the other. A time in reality very considerable elapses after the first appearance of fish, before any with reptilian characters are found. If the least time elapsed, or though their origin were all but contemporaneous, it would be enough for our hypothesis, seeing that we do not know but that the conditions which admitted of the first development of fish may have been of a character to produce such reptilian adaptations as we see in the sauroid family; these adaptations being, we know, an indifferent matter compared with the development of the grand features of internal organization. As to the subsequent rise of new fishes, not in any degree reptilian, it can be no difficulty when we understand the main line of animal development to be, as many facts seem to imply, not singular, but plural—a rope of several strands.

The pedigree of the *Reptilia* is also obscure. The class comprehends four leading forms or orders, the *Amphibia*,* *Sauria*, *Chelonia*, and

* Generally, the same as the Batrachia, (frogs, toads, &c.)

Ophidia. The first are remarkable for the metamorphosis they pass through before they reach maturity, being ushered into active existence as fishes, but ultimately transformed into reptiles. There are traces of batrachia of large size early in the New Red Sandstone; saurians and chelonia occur soon after; but ophidia do not make their appearance till the Tertiary Formation. That the amphibia are immediately descended from fishes is proved by their embryotic history. There are species (*lepidosirens*) which are only distinguished from fishes by having four filament-like legs, besides a few minor peculiarities. Others (proteus, menobranchus, &c.) retain the branchiæ of the fish all their lives, and never leave the water. The salamander, frog, and some other genera, change the gills for lungs, and pass from the water to the land; a step in animal progress which seems necessarily connected with improved organization. The atmosphere-breathing amphibia are destined at the most for living in marshes and moist shady places. The lower chelonia are in like manner devoted to marine life, and these are provided with paddles for swimming. After them come fresh-water and land families. The commencement of the great saurian order appears to be in those marine genera of which the ichthyosaurus is an example, a group

of animals retaining many fish features in connexion with those of the sauria. By the Nothosaurus, there seems to be a passage from these animals to the *Crocodilia;* that is to say, great saurians of the sea furnish progeny fitted to dwell in great rivers, and partly move on land. There are, besides, many small saurian animals, fitted by their organization to swim the lake, to run rapidly over the ground, and to inhabit trees. The genealogies of these may be left for future inquiry, as may also be that of the order Ophidia.*

The crocodiles, in the form of the skull and stomach, approach the bird character, and might thus be supposed to lead on to that class. But probably, this is merely such an advance to the characters of a higher class as we find in the cephalopoda; not the indication of an affinity or genetic connexion, but a high degree of organization in an independent line, coming to a point abreast with certain

* Between the lizards and serpents there is a series of intermediate forms in which we see the limbs gradually disappearing. One of the lowest of the saurian genera (bimanes) gives only two little feet appended to the frame-work of the shoulder. These facts would seem to indicate that the serpents have proceeded from the lizards. But on the other hand we have a like connexion from the frogs to the serpents by the cecilia or blind serpent, an animal destitute of a scaly covering, having a soft skin like that of the batrachia, and resembling the latter in many points of internal organization.

characters in superior class. The penguin, in its fin-like wings, and the posterior position of the feet, points to a more probable origin for this class in the fishes. Whencesoever the birds may arise, there can be no doubt of the Natatorial order being the first and lowest, and of the divers (penguin, auk, &c.) being the humblest of that order. The grade of the bird orders is well marked in a fact of their economy: the natatores, grallatores, and rasores are independent almost as soon as they leave the egg; the other orders prove their superiority by requiring careful parental nurture.

It is well here to remark that, if the birds spring from the fishes, their being in existence so early as the new red sandstone, while as yet reptile life was not advanced to its height, is in no respect inconsistent with what was to have been expected.

The succession of bird orders here indicated is in conformity with the rule as to land animals branching off in lines from the aquatic. From certain natatores come the long and bare-legged and long-billed grallatores, fitted to live and gather their food upon shores and amidst shallow waters of whatever kind. And in this order we find various families fitted for various stages of such an existence, intermediate between sea and land—the *Phalleropidæ* (comprising lo-

bipes and holopodius) and the *Flamingoes*, being in a great degree natatorial, or near to that order in form and habits; the *Scolopacidæ*, (curlews, snipes, and sand-pipers,) extending again from shores to rivers and marshes; the *Ardeidæ*, (herons,) quitting shores, and confining themselves to rivers, lakes, and wet grounds; the *Rallidæ*, (rails,) extending again from these to dry grounds, to which, finally, the *Bustards* and *Cranes* are wholly limited. Thus organization and connexions of forms pass on from the sea to the land, apparently by a genesis precisely following the stages of the development of the physical surface. In the bustards we see the grallatorial structure melting towards the rasorial, which is probably continued through a similar succession of forms, in coincidence with the coming into existence of habitats appropriate to them, and the development of the plants whose seeds were to supply them with food. The *Insessorial* birds follow as a family adapted mainly for sylvan life. The *Raptores*, so different in form and character from the rest, have probably a distinct root in the natatores, somewhere in that group which includes the albatross and petrel (animals fully carnivorous, though aquatic); littoral and connecting genera being presented in such animals as the osprey and those falconidæ which haunt sea-

cliffs and live upon fish. Of the descent of the *Scansores* I would only remark that the four diverse families of which they are made up are all probably grades in distinct genetic lines, agreeing only in their common adaptation to a life of climbing.

Finally, we have to investigate the descent of the highest of the vertebrate classes, the Mammalia. It is common, amidst the obscurity of our present knowledge of animal affinities, to speak of the birds generally as standing between the fishes and vertebrata; but, though they have an intermediate place in grade of organization, they may not have one in animal genealogy. On the contrary, there is much reason to believe that certain large and important series of mammals, if not the whole, have proceeded directly from the reptiles. In the cetiosaurus, a crocodilian of the oolite, it is startling to hear that affinities to the *cetacea* have been observed. It seems to imply that there has been a passage from the marine saurians to the aquatic mammals. The consideration of the size of the cetacea is favourable to this idea, for, if their descent be as surmised, there would be no alteration in the bulk of the parent.

The carnivorous cetacea are seen, again, to pass,

by the diodon and neighbouring genera into the ill-defined family which used to be called the dolphins. The herbivorous cetacea (dugong, manatus, etc.) are considered as having little affinity to the carnivorous, and probably they form a separate though parallel and neighbouring line. However this may be, the passage from them to the *Pachydermata*, or thick-skinned animals of Cuvier, is universally acknowledged and may be considered amongst the clearest of our facts. The thick and naked skin, the gigantic body, the massive bones, the bulky head, and even the variable and irregular teeth,* all point out this relationship. Here again we have a natural progress in striking harmony with geographical conditions. First come animals of which the extinct dinotherium and the living hippopotamus are examples, spending nearly their whole time in rivers; an easy extension of mammalian population being thus made from the shores of the ocean to the embouchures of its fresh-water accessories. If we suppose such rivers to have speedily become margined with jungle and savannah, we shall see what might be with no disrespectful meaning called a provocation to the existence of the adjoining family,

* In the microscopic structure of the tusks no distinction whatever can be detected.

the *Proboscidiana* of Cuvier, (mastodon, elephant, etc.,) creatures equally huge with their fluvial progenitors, but fitted to enjoy the warm yet shady humidity of tropical woods, and to derive their subsistence from the superabundant foliage. From these, again, come the *Tapiridæ*, animals generally of smaller size, and in which the proboscis appears shrunk to little more than a snout, this last deprivation being compensated by a longer and more flexible neck. These animals once abounded on the geographical situation of Europe, but are now only represented by a few obscure-living species in South America.

Thus is explained the marvel with respect to the huge bulk of many of the tertiary mammalia: they were immediate in descent from the cetacea. Their being comparatively numerous in the tertiary era may be attributed to the estuarial and deltoid character of that time. In the tapirs the magnitude sinks down to ordinary proportions; witness the anoplotheria. Meanwhile, from the rhinoceros, appear to have arisen another great family, snouted like the tapirs, but fitted by that organ for seeking their food (roots and seeds) in the ground and amidst brushwood — namely, the *Suidæ*, or hogs. The peccaries of South America, the phacochærus of South Africa, the babyroussa

of Southern Asia, and the pigs of Europe, appear as the parallel, though slightly varied results of so many independent developments from this root. All of these animals are mainly fitted for living in woods and low soft grounds. Their tendency to extension of the canine teeth is a general feature, which sinks in the domesticated pigs, but rises again when these animals are left to grow wild for several generations,—an example of development following upon the experience of needs which is perfectly conformable to the present hypothesis, but is explicable upon no other.

Suppose advance in physical conditions to go on —the inland country, we shall say, rising into dry elevations, either through local volcanic movement, or that general elevation of the land above the level of the sea, which we have seen demonstrated—and these elevations to be covered with a vegetation confined to herbage, and that perhaps scanty, and we find appropriate creatures in a family which bear many traces of genetic connexion with the tapiridæ—namely, the *Equidæ*, which, in a wild state, still occupy such grounds, the poverty of which they overcome by their power of swift movement from one feeding place to another. In the prehensile upper lip of the horse we see the last relic of the proboscis of the elephants and

tapirs. The clumping of the extremities into one shield or hoof, serving to support the body of the animal in soft dry soil, sufficiently shews what kind of habitat determined the production of this interesting and, as it has proved, useful genus.

So end the pachydermata. Naturalists speak of connexions between these and the equally great *Ruminant* order; but I suspect that the marks of affinity are deceptious, and, considering the distinct general character of these orders, deem it much more likely that the Ruminants have had a distinct origin in the genus of herbivorous cetacea represented by the existing walrus or morse, whose outward-bending tusks we see in a reduced form in the musk-deer. What greatly supports this conclusion is, that of the three genera of the moschidæ one is aquatic, while the elks are lovers of moist shady grounds, and spend much of their time in water during the summer season. In this line, equally as in the pachydermata, we find other families (bovidæ, cervidæ, etc.) extending to open grazing grounds; the last betaking themselves also to hills of gentle elevation; while the sheep and goats are fitted for a still loftier and drier habitat.

Another line of mammalian land life commences with the *Seals*, a large and various group of marine animals, all agreeing in a carnivorous structure and

mode of existence. From the *Otaria*, a ferocious genus, clearly proceed the *Sea-Otters*, a set of animals greatly resembling the otaries, having the ears rounded, and the hind legs placed far back, with a short tail. These again lead to the common *Otter*, an animal whose river habits, webbed extremities, and awkwardness of movement out of the water, plainly denote its nearness to the phocidæ and its intermediateness between aquatic and land life. Thus we have first the seals, coast animals; next, sea-otters, which live upon tide-washed rocks; and then common-otters, whose sphere of being is in rivers; a gradation precisely such as we have already seen in other genetic lines. From the last I have no doubt that the *Mustelidæ* (polecat, foumart, &c.,) take their rise, some of these still being of partially aquatic habits, and all being equally destructive of the smaller animals. The ichneumon, surikate, &c., appear to be of this line, and they acknowledgedly lead to the *Viverridæ*, (civets and genets,) from which again, by the proteles, we reach the *Canidæ*, a family of which one species (the dog) has relented somewhat from the ferocity of the tribe, though still, as is well known, a carnivorous animal. Naturalists connect the viverridæ by the cryptoprocta with the *Felinæ*; but here also they are deceived by parities passing for affinities.

There can hardly be a doubt that this great family derive their descent more immediately from some of the seal family, probably the genus named the sea-lion.

The *Rodentia*, so distinguished by their peculiar teeth, are, doubtless, an independent line, commencing with the aquatic genera, and going on to burrows and inhabitants of the wilds and the woods. Not less distinct are the *Ursidæ*, beginning with the water-haunting arctic bear as an immediate descendant of a well-known analogue among the seals, and going on to the racoons. The *Insectivora* stand in like manner apart, passing from such aquatic types as the desman through the moles, shrews, &c. Of the *Edentate* order we may look for the initial forms among the extinct species. The Rodentia and Edentata are remarked to be nearer to the birds than some other mammalian orders, particularly in their brain and the mean form or entire absence of teeth; and this induces many naturalists to place them as intermediate forms between the birds and higher mammalia. But this may only be the indication of a degree of organization reached in a line independent of the birds, not the mark of an affinity.

The same remark and explanation may be presented with reference to the most humbly formed

of all mammalia, the *Marsupialia* and *Monotremata;* and here the explanation receives some support from the strong infusion of reptilian characters in these orders. Amongst the Australian marsupials it is remarkable that we find species presenting in their dentition and general aspect affinities to the rodent, insectivorous, canine, and ruminant orders, as if we there had preparations or intermediate stages for the future development of animals of those various characters. Whether such have been the design of nature, for we only find in the Australian continent representatives of this inferior character, of orders more fully developed elsewhere, and through different media, I will not undertake to say. It is important, however, to find in two genera, (phalangista and petaurus), which inhabit the Indian Archipelago, species possessing characters which appear to lead on to the *Quadrumana.* It is on the hind-foot of these creatures that we light upon the first trait of human organization, in an opposable thumb. And the nativity, it will be observed, agrees with that of a large portion of the quadrumanous order. It might now be desirable to trace the connexions of that order in their upward progress towards the highest of animated beings; but here such obscurity prevails, that I must be content to leave the task to other inquirers.

Let me, however, remark that the separate development of the quadrumana—a fact of which I do not see how any doubt can be entertained—at once explains how remains of that order may be found in the Sivalik hills, the Woodbridge quarries, or any other part of the earth, in association with the bones of pachydermata. The two sets of animals, with perhaps others, went on in development together, contemporaries, although not parallel in organization, and springing from different portions of the animal kingdom.*

Enough, I trust, has now been done to shew how the peopling of this earth with the inferior tribes took place. The great trunk of animality lies in the ocean, up even to the mammalian type. Thence have proceeded, at various epochs, and from various points or grades, branches destined to a terrestrial life, and which have equally with the main line, had a development connected with a

* In this chapter I have generally avoided the details of structure which shew the affinities, from a fear of losing the attention of the ordinary reader. But these can be studied in many accessible compendiums of zoology, as Griffith's edition of Cuvier, the works of Professors Owen, Bell, and Rymer Jones, and Todd's Cyclopedia of Physiology. A still more satisfactory study would be found in the great collection of John Hunter in the Royal College of Surgeons.

grand though obscure chronology. Thus, from sea to shore, and from shore to swamp and forest, and from forest to prairie and wild, as these were formed in the course of our geognostic history, have spread the appropriate beings, to work out the great divine design that every space which could sustain life should possess it, and be to it a field of enjoyment. Even the soil itself became a theatre for the existence of certain humble families, while the air, on the other hand, was not forgotten, but received tenants which seem as if they had caught colours from the light in which they revelled. Last of all issued from the woods a being erect, majestic, and with many traits of external grace and beauty, to overspread the whole earth with his race, to turn all beneath him in organization to his own pleasure, and manifest more than all that glory of the Creator, which he alone could even attempt to understand.

It is as yet but a few years since an eminent naturalist announced the discovery of certain analogies in the various portions of the animal kingdom, leading to the idea that every natural group consists of five portions, in each of which there is a certain character, repeated in the corresponding

portions of all the other groups. Beginning with the class of birds, Mr. Macleay and his followers shewed that it could be divided into five orders: *natatores* (swimmers), *grallatores* (waders), *rasores* (scrapers), *insessores* (perchers), and *raptores* (birds of prey). In these orders they found distinct organic and moral characters, the insessores being the most perfectly organized, and the grallatores the least so, the rasores being as gentle in their dispositions as the raptores were the reverse, and so forth. According to our naturalists, the organic and moral properties belonging to these orders were found faintly shadowed in each *tribe* of each order of birds, and more faintly still in each family of each tribe, all of these divisions consisting of five. Nor was this all. The same characters were to be seen in each class of each sub-kingdom, and in all the lower divisions of these, as in the birds; and even the sub-kingdoms themselves were natatorial, grallatorial, rasorial, raptorial, and insessorial. At the same time, all these divisions, of whatever grade, were held to be circular; that is, starting from any portion of the group, it was held that we passed along a range of minute gradations until we returned to the same point. This view of the constitution of the animal kingdom has lat-

terly been abandoned by many who at one time embraced it, in consequence of its being found to involve so many difficulties. But it possesses a basis in truth. What appears to have been the chief error, was the endeavour, under the influence of a theorizing spirit, to extend the application of the supposed rule to divisions and sub-divisions with which it had no concern. The preceding view of genetic connexions suggests the degree in which the theory is true. It appears that the animal kingdom consists of a set of lines, having the ocean for a medium or field of existence; and these lines may be considered as consisting of series of groups equivalent to those which the Macleay school would call natatorial. From each of a certain number of these, if not from all above a certain point in the scale, branches off a lateral line, which, passing first through a dubious stage in which we see adaptations for shore, river, and marsh life, and thus forming the grallatorial or suctorial type of our naturalists, goes on to other forms adapted for modes of existence expressly terrestrial. Amongst these we see, with sufficient clearness, one group adapted for field-cropping, another for living among trees, a third for burrowing, and so on. Of course, the circumstances of these

groups being alike, it is not surprising that they are all furnished and set out by nature with features more or less common. For example, the chameleons, scansorial birds, squirrels, and simiæ, being all arboreal groups in their respective lines, designed readily to climb and find their food amongst trees, we might reasonably expect such a resemblance in the extremities of these animals as is known to exist, all of them being peculiarly adapted for grasping branches. So also we might suppose that the gallinaceæ would stand in some degree of analogy with the ruminant quadrupeds, seeing that they both alike live mainly upon vegetable diet obtained on the fields. Their place in creation being the same, the animals are somewhat similar—shall we say because the place determines the character of the animal? Many other such illustrations might be added, and there is little room to doubt that, if this walk were followed out, some entirely new views respecting classification would soon occur. There is a general conviction that the arrangement now most in vogue, that of Cuvier, can only last a little while, as not being natural. Might it not be well to consider how far it is possible to attain a just classification, by endeavouring to ascertain the series of forms in the central and various

branching lines. The latter would all be found to possess common characters within themselves; their vertical affinities and horizontal analogies would alike be instructive and an aid to memory; their presumed history would excite an interest in them as a department of useful knowledge; and for the present confused scene, baffling all but life-long attention, we should have a system at once simple and beautiful, in which children might soon become proficient.

Let us now consider the facts known regarding the geographical distribution of plants and animals in connexion with the genetic hypothesis.

Plants, as is well known, require various kinds of soil, forms of geographical surface, climate, and other conditions, for their existence. And it is everywhere found that, however isolated a particular spot may be with regard to these conditions,—as a mountain top in a torrid country, the marsh round a salt spring far inland, or an island placed far apart in the ocean,—appropriate plants have there taken up their abode. But the torrid zone divides the two temperate regions from each other by the space of more than forty-six degrees, and the torrid and temperate zones together form a much broader line of division between the two

arctic regions. The Atlantic and Pacific Oceans, and the Persian Gulf, also divide the various portions of continent in the torrid and temperate zones from each other. Australia is also divided by a broad sea from the continent of Asia. Thus various portions of the earth are separated in such a way as to preclude anything like a general communication of the seeds of their respective plants towards each other. Hence arises an interesting question—Are the plants of the various isolated regions which enjoy a parity of climate and other conditions, identical or the reverse? The answer is—that in such regions the vegetation bears a general resemblance, but the *species* are nearly all different, and there is even, in a considerable measure, a diversity of *families.*

The general facts have been thus stated: In the arctic and antarctic regions, and in those parts of lower latitudes which, from their elevation, possess the same cold climate, there is always a similar or analogous vegetation, but few species are common to the various situations. In like manner, the intertropical vegetation of Asia, Africa, and America, are specifically different, though generally similar. The southern region of America is equally diverse from that of Africa, a country similar in clime, but separated by a vast extent of

ocean. The vegetation of Australia, another region similarly placed in respect of clime, is even more peculiar. These facts are the more remarkable when we discover that, in most instances, the plants of one region have thriven when transplanted to another of parallel clime. This would shew that parity of conditions does not lead to a parity of productions so exact as to include identity of species, or even genera. Besides the various isolated regions here enumerated, there are some others indicated by naturalists as exhibiting a vegetation equally peculiar. Some of these are isolated by mountains, or the interposition of sandy wastes. For example, the temperate region of the elder continent is divided about the centre of Asia, and the east of that line is different from the west. So also is the same region divided in North America by the Rocky Mountains. Abyssinia and Nubia constitute another distinct botanical region. De Candolle enumerates in all twenty well-marked portions of the earth's surface which are peculiar with respect to vegetation; a number which would be greatly increased if remote islands and isolated mountain ranges were to be included.

When we come to the zoology, we find precisely similar results, excepting that man (with, perhaps,

some of the less conspicuous forms of being) is universal, and that several tribes, as the bear and dog, appear to have passed by the land connexion from the arctic regions of the eastern to those of the western hemisphere. "With these exceptions," says Dr. Prichard, "and without any others, as far as zoological researches have yet gone, it may be asserted that no individual species are common to distant regions. In parallel climates, analogous species replace each other; sometimes, but not frequently, the same genus is found in two separate continents; but the species which are natives of one region are not identical with corresponding races indigenous in the opposite hemisphere.

"A similar result arises when we compare the three great intertropical regions, as well as the extreme spaces of the three great continents, which advance into the temperate climates of the southern hemisphere.

"Thus, the tribes of simiæ, (monkeys,) of the dog and cat kinds, of pachyderms, including elephants, tapirs, rhinoceroses, hogs, of bats, of saurian and ophidian reptiles, as well of birds and other terrene animals, are all different in the three great continents. In the lower departments of the mammiferous family, we find that the bruta, or edentata, (sloths, armadillos, &c.,) of Africa, are

differently organized from those of America, and these again from the tribes found in the Malayan archipelago and Terra Australis."*

It does not appear that the diversity between the similar regions of Africa, Asia, and America, is occasioned in all instances by any disqualification of these countries to support precisely the same genera or species. The ox, horse, goat, &c., of the elder continent have thriven and extended themselves in the new, and many of the indigenous tribes of America would no doubt flourish in corresponding climates in Europe, Asia, and Africa. It has, however, been remarked that the larger and more powerful animals of their respective orders belong to the elder continent, and that thus the animals of America, unlike the features of inanimate nature, appear to be upon a small scale. The swiftest and most agile animals, and a large proportion of those most useful to man, are also natives of the elder continent. On the other hand, the bulk of the edentata, a group remarkable for meanness of organization, are American. The zoology of America may be said, upon the whole, to recede from that of Asia, "and perhaps in a greater degree," adds Dr. Prichard, "from that of Africa." A much greater recession is, however,

* Researches in the Physical History of Man, 4th edition, i. 95.

observed in both the botany and zoology of Australia.

There, vegetation is generally gloomy and sad, having the aspect of our evergreens or heaths; the plants are for the most part woody; the leaves of nearly all the plants are linear, lanceolated, small, coriaceous, and spinescent. The grasses, which elsewhere are generally soft and flexible, participate in the stiffness of the other vegetables. The greater part of the plants belong to new genera; and those included in the genera already known are of new species. The natural families which prevail are those of the heaths, the proteæ, compositæ, leguminosæ, and myrtaceæ.*

The prevalent animals of Australia are not less peculiar. They consist of monotremata and marsupialia. The former are a small group of animals (echidna and ornithorhynchus) little above the *grade* of birds, some of whose externals they present, but considered by Professor Owen as in near affinity to the reptiles,—an opinion in harmony with the genetic plan here sketched. The marsupialia have already been described: it has of late been discovered that there formerly existed, in this

* Prichard.

continent, marsupials considerably larger than any species now living, and an additional family representing the pachydermata. The birds of Australia vary in structure and plumage, but all have some singularity about them—the swan, for instance, is black. The country abounds in reptiles, and the prevalent fishes are of the early kinds, having a cartilaginous structure.

Altogether, the plants and animals of this minor continent convey the impression of an early system of things, such as might be displayed in other parts of the earth about the time of the oolite. In connexion with this circumstance, it is a fact of some importance, that the geognostic character of Australia, its vast arid plains, its little diversified surface and consequent paucity of streams, and the very slight development of volcanic rock on its surface, seem to indicate a system of physical conditions, such as we may suppose to have existed elsewhere in the oolitic era: perhaps we see the chalk formation preparing there in the vast coral beds frontiering the coast. Australia thus appears as a portion of the earth which has, from some unknown causes, been belated in its physical and organic development.

The general conclusions regarding the geography of organic nature may be thus stated. (1.) There are numerous distinct foci of organic production throughout the earth. (2.) These have everywhere advanced in accordance with the local conditions of climate, &c., as far as at least the class and order are concerned, a diversity taking place in the minor gradations. (3.) Development has not gone on to equal results in the various continents, being most advanced in the eastern continent, next in the western, and least in Australia, this inequality being perhaps the result of the comparative antiquity of the various regions, geologically and geographically.

Do not these results appear strikingly in harmony with the idea of such a development of organisms along genealogical lines, as has been explained in the present work? There is assuredly nothing in the above account of the geographical distribution of plants and animals which that theory will not account for. Those genealogies proceeded in various parts of the earth at one or at different periods, following everywhere the progress from aquatic to terrestrial forms, but coming to slightly various results in the extreme ramifications (genera and species) through the efficacy of conditions so far various.

EARLY HISTORY OF MANKIND.

THE human race is known to consist of numerous nations, displaying considerable differences of external form and colour, and speaking in general different languages. This has been the case since the commencement of written record. It is also ascertained that the external peculiarities of particular nations do not change rapidly. While a people remain upon one geographical area, and under the influence of one set of conditions, they always exhibit a tendency to persistency of type, insomuch that a subordinate admixture of various type is usually obliterated in a few generations. Numerous as the varieties are, they have all been found classifiable under five leading ones:—1. The Caucasian, or Indo-European, which extends from India into Europe and Northern Africa; 2. The

Mongolian, which occupies Northern and Eastern Asia; 3. The Malayan, which extends from the Ultra-Gangetic Peninsula into the numerous islands of the South Seas and Pacific; 4. The Negro, chiefly confined to Africa; 5. The aboriginal American. Each of these is distinguished by certain general features of so marked a kind, as to suggest to many inquirers, that they have had distinct or independent origins. Of these peculiarities, colour is the most conspicuous: the Caucasians are generally white, the Mongolians yellow, the Negroes black, and the Americans red. The opposition of two of these in particular, white and black, is so striking, that of them, at least, it seems almost necessary to suppose separate origins. Of late years, however, the whole of this question has been subjected to a rigorous investigation by a British philosopher, who has successfully shewn that the human race might have had one origin, for anything that can be inferred from external peculiarities.

It appears from this inquiry,* that colour and other physiological characters are of a more superficial and accidental nature than was at one time

* See Dr. Prichard's Researches into the Physical History of Man.

supposed. One fact is at the very first extremely startling, that there are nations, such as the inhabitants of Hindostan, apparently one in descent, which nevertheless contain groups of people of almost all shades of colour, and likewise discrepant in other of those important features on which much stress has been laid. Some other facts, which I may state in brief terms, are scarcely less remarkable. In Africa, there are Negro nations,—that is, nations of intensely black complexion, as the Jolofs, Mandingoes, and Kafirs, whose features and limbs are as elegant as those of the best European nations. While we have no proof of Negro races becoming white in the course of generations, the converse may be held as established, for there are Arab and Jewish families of ancient settlement in Northern Africa, who have become as black as the other inhabitants. There are also facts which seem to shew the possibility of a natural transition by generation from the black to the white complexion, and from the white to the black. True whites, (apart from Albinoes,) are not unfrequently born among the Negroes, and the tendency to this singularity is transmitted in families. There is, at least, one authentic instance of a set of perfectly black children being

born to an Arab couple, in whose ancestry no such blood had intermingled. This occurred in the valley of the Jordan, where it is remarkable that the Arab population in general have flatter features, darker skins, and coarser hair, than any other tribes of the same nation.*

The style of living is ascertained to have a powerful effect in modifying the human figure in the course of generations, and this even in its osseous structure. About two hundred years ago, a number of people were driven by a barbarous policy from the counties of Antrim and Down, in Ireland, towards the sea-coast, where they have ever since been settled, but in unusually miserable circumstances, even for Ireland; and the consequence is, that they exhibit peculiar features of the most repulsive kind, projecting jaws with large open mouths, depressed noses, high cheek bones, and bow legs, together with an extremely diminutive stature. These, with an abnormal slenderness of the limbs, are the outward marks of a low and barbarous condition all over the world; it is particularly seen in the Australian aborigines.

* Buckingham's Travels among the Arabs. This fact is the more valuable to the argument, as having been set down with no regard to any kind of hypothesis.

On the other hand, the beauty of the higher ranks in England is very remarkable, being, in the main, as clearly a result of good external conditions. "Coarse, unwholesome, and ill-prepared food," says Buffon, "makes the human race degenerate. All those people who live miserably are ugly and ill-made. Even in France, the country people are not so beautiful as those who live in towns; and I have often remarked that in those villages where the people are richer and better fed than in others, the men are likewise more handsome, and have better countenances." He might have added, that elegant and commodious dwellings, cleanly habits, comfortable clothing, and being exposed to the open air only as much as health requires, co-operate with food in increasing the elegance of a race of human beings.

Subject to these modifying agencies, and perhaps to some others of a less appreciable nature, connected with physical geography, there is, as has been said, a remarkable persistency in national features and forms, insomuch that a single individual thrown into a family different from himself is absorbed in it, and all trace of him lost after a few generations. Such permanency may, like that of species, be the rule, but the exceptive

variations, which result from causes obvious or obscure, are also of a prominent character. They seem to tend most to occur among the humbler families of plants and animals, but also frequently take place in the very highest. A notable instance of variety-production in an animal family by no means low, is often referred to, as having occurred under the observation of persons still alive to attest it. On a New England farm there originated, in the latter part of the last century, a variety of sheep with unusually short legs, which was kept up by breeding, on account of the convenience in that country of having sheep which are unable to jump over low fences. The starting and maintaining a *breed* of cattle, that is, a variety marked by some desirable peculiarity, are familiar to a large class of persons. It appears only necessary, when a variety has been thus produced, that a union should take place between individuals similarly characterized, and that the conditions under which it has been produced should be persisted in, in order to establish it. Early in the last century, a man named Lambert, was born in Suffolk, with semi-horny excrescences of about half an inch long, thickly growing all over his body. The peculiarity was transmitted to his children, and was last heard

of in a third generation. The peculiarity of six fingers on the hand and six toes on the feet, appears in like manner in families which have no record or tradition of such a peculiarity having affected them at any former period, and it is then sometimes seen to descend through several generations. It was Mr. Lawrence's opinion, that a pair, in which both parties were so distinguished, might be the progenitors of a new variety of the race who would be thus marked in all future time. We have but obscure notions of the laws which regulate this variability within specific limits; but we see them continually operating, and they are obviously favourable to the supposition that all the great families of men are of one stock.

The tendency of the modern study of the languages of nations is to the same point. The last fifty years have seen this study elevated to the character of a science, and the light which it throws upon the history of mankind is of a most remarkable nature.

Following a natural analogy, philologists have thrown the earth's languages into a kind of classification: a number bearing a considerable resemblance to each other, and in general geographically near, are styled a *group* or *sub-family;* several groups, again, are associated as a *family*, with regard

to more general features of resemblance. Six families are spoken of.

The Indo-European family nearly coincides in geographical limits with those which have been assigned to that variety of mankind which generally shews a fair complexion, called the Caucasian variety. It may be said to commence in India, and thence to stretch through Persia into Europe, the whole of which it occupies, excepting Hungary, the Basque provinces of Spain, and Finland. Its sub-families are the Sanskrit, or ancient language of India, the Persian, the Slavonic, Celtic, Gothic, and Pelasgian. The Slavonic includes the modern languages of Russia and Poland. Under the Gothic, are (1) the Scandinavian tongues, the Norske, Swedish, and Danish; and (2) the Teutonic, to which belong the modern German, the Dutch, and our own Anglo-Saxon. I give the name of Pelasgian to the group scattered along the north shores of the Mediterranean, the Greek and Latin, including the modifications of the latter under the names of Italian, Spanish, &c. The Celtic was, from two to three thousand years ago, the speech of a considerable tribe dwelling in Western Europe; but these have since been driven before superior nations into a few corners, and are

now only to be found in the highlands of Scotland, Ireland, Wales, Cornwall, and certain parts of France. The Gaelic of Scotland, Erse of Ireland, and the Welsh, are the only living branches of this sub-family of languages.

The resemblances amongst languages are of two kinds,—identity of words, and identity of grammatical forms; the latter being now generally considered as the most important towards the argument. When we inquire into the first kind of affinity among the languages of the Indo-European family, we are surprised at the great number of common terms which exist amongst them, and these referring to such primary ideas, as to leave no doubt of their having all been derived from a common source. Colonel Vans Kennedy presents nine hundred words common to the Sanskrit and other languages of the same family. In the Sanskrit and Persian, we find several which require no sort of translation to an English reader, as *pader, mader, sunu, dokhter, brader, mand, vidhava;* likewise *asthi,* a bone, (Greek, *ostoun;*) *denta,* a tooth, (Latin, *dens, dentis;*) *eycumen,* the eye; *brouwa,* the eye-brow, (German, *braue;*) *nasa,* the nose; *karu,* the hand, (Gr. *cheir;*) *genu,* the knee, (Lat. *genu;*) *ped,* the foot, (Lat. *pes, pedis;*) *hrti,* the

heart; *jecur*, the liver, (Lat. *jecur*;) *stara*, a star; *gela*, cold, (Lat. *gelu*, ice;) *aghni*, fire, (Lat. *ignis*;) *dhara*, the earth, (Lat. *terra*, Gaelic, *tir*;) *arrivi*, a river; *nau*, a ship, (Gr. *naus*, Lat. *navis*;) *ghau*, a cow; *sarpam*, a serpent.

The inferences from these verbal coincidences were confirmed in a striking manner when Bopp and others investigated the grammatical structure of this family of languages. Dr. Wiseman pronounces that the great philologist just named, "by a minute and sagacious analysis of the Sanskrit verb, compared with the conjugational system of the other members of this family, left no doubt of their intimate and positive affinity." It was now discovered that the peculiar terminations or inflections by which persons are expressed throughout the verbs of nearly the whole of these languages, have their foundations in pronouns; the pronoun was simply placed at the end, and thus became an inflection. "By an analysis of the Sanskrit pronouns, the elements of those existing in all the other languages were cleared of their anomalies; the verb substantive, which in Latin is composed of fragments referable to two distinct roots, here found both existing in regular form; the Greek conjugations, with all their complicated machinery

of middle voice, augments and reduplications, were here found and illustrated in a variety of ways, which a few years ago would have appeared chimerical. Even our own language may sometimes receive light from the study of distant members of our family. Where, for instance, are we to seek for the root of our comparative *better?* Certainly not in its positive, good, nor in the Teutonic dialects in which the same anomaly exists. But in the Persian we have precisely the same comparative, *behter*, with exactly the same signification, regularly formed from its positive *beh*, good."*

The second great family of languages is the *Syro-Phœnician*, comprising the Hebrew, Syro-Chaldaic, Arabic, and Gheez or Abyssinian, being localized principally in the countries to the west

* Wiseman's Lectures on the Connexion between Science and Revealed Religion, i. 44. The Celtic has been established as a member or group of the Indo-European family, by the work of Dr. Prichard, *on the Eastern Origin of the Celtic Nations.* "First," says Dr. Wiseman, "he has examined the lexicon resemblances, and shewn that the primary and most simple words are the same in both, as well as the numerals and elementary verbal roots. Then follows a minute analysis of the verb, directed to shew its analogies with other languages, and they are such as manifest no casual coincidence, but an internal structure radically the same. The verb substantive, which is minutely analyzed, presents more striking analogies to the Persian verb than perhaps any other

and south of the Mediterranean. Beyond them, again, is the African family, which, as far as research has gone, seems to be in like manner marked by common features, both verbal and grammatical. The fourth is the Polynesian family, extending from Madagascar on the west, through the Indian Archipelago, besides taking in the Malayan dialect from the continent of India, and comprehending Australia and the islands of the western portion of the Pacific. This family, however, bears such an affinity to that next to be described, that Dr. Leyden and some others do not give it a distinct place as a family of languages.

The fifth family is the Chinese, embracing a large part of China, and most of the regions of Central and Northern Asia. The leading features of the Chinese language are, its consisting alto-

language of the family. But Celtic is not thus become a mere member of this confederacy, but has brought to it most important aid; for, from it alone can be satisfactorily explained some of the conjugational endings in the other languages. For instance, the third person plural of the Latin, Persian, Greek, and Sanscrit ends in nt, nd, *ντι*, *ντο*, nti, or nt. Now, supposing, with most grammarians, that the inflections arose from the pronouns of the respective persons, it is only in Celtic that we find a pronoun that can explain this termination; for there, too, the same person ends in nt, and thus corresponds exactly, as do the others, with its pronoun, *hwynt*, or *ynt*."

gether of monosyllables, and being destitute of all grammatical forms, except certain arrangements and accentuations, which vary the sense of particular words. It is also deficient in some of the consonants most conspicuous in other languages, b, d, r, v, and z; so that this people can scarcely pronounce our speech in such a way as to be intelligible: for example, the word Christus they call *Kuliss-ut-oo-suh.* The Chinese, strange to say, though they early attained to a remarkable degree of civilization, and have preceded the Europeans in many of the most important inventions, have a language which resembles that of children, or deaf and dumb people. The sentence of short, simple, unconnected words, in which an infant amongst us attempts to express some of its wants and its ideas —the equally broken and difficult terms which the deaf and dumb express by signs, as the following passage of the Lord's Prayer:—"Our Father, heaven in, wish your name respect, wish your soul's kingdom providence arrive, wish your will do heaven earth equality," &c.—these are like the discourse of the refined people of the so-called Celestial Empire. An attempt was made by the Abbé Sicard to teach the deaf and dumb grammatical signs; but they persisted in restricting them-

selves to the simple signs of ideas, leaving the structure undetermined by any but the natural order of connexion. Such is exactly the condition of the Chinese language.

Crossing the Pacific, we come to the last great family in the languages of the aboriginal Americans, which have all of them features in common, proving them to constitute a group by themselves, without any regard to the very different degrees of civilization which these nations had attained at the time of the discovery. The common resemblance is in the grammatical structure as well as in words, and the grammatical structure of this family is of a very peculiar and complicated kind. The general character in this respect has caused the term Polysynthetic to be applied to the American languages. A long many-syllabled word is used by the rude Algonquins and Delawares to express a whole sentence: for example, a woman of the latter nation, playing with a little dog or cat, would perhaps be heard saying, "*kuligatschis*," meaning, "give me your pretty little paw;" the word, on examination, is found to be made up in this manner: *k*, the second personal pronoun; *uli*, part of the word wulet, pretty; *gat*, part of the word wichgat, signifying a leg or paw; *schis*, conveying

the idea of littleness. In the same tongue, a youth is called pilape, a word compounded from the first part of pilsit, innocent, and the latter part of lenape, a man. Thus, it will be observed, a number of parts of words are taken and thrown together, by a process which has been happily termed *agglutination*, so as to form one word, conveying a complicated idea. There is also an elaborate system of inflection; in nouns, for instance, there is one kind of inflection to express the presence or absence of vitality, and another to express number. The genius of the language has been described as accumulative; it "tends rather to add syllables or letters, making farther distinctions in objects already before the mind, than to introduce new words."* Yet it has also been shewn very distinctly, that these languages are based in words of one syllable, like those of the Chinese and Polynesian families; all the primary ideas are thus expressed: the elaborate system of inflection and agglutination is shewn to be simply a farther development of the language-forming principle, as it may be called—or the Chinese system may be described as an arrestment of this principle at a particular early point. It

* Schoolcraft.

has been fully shewn, that between the structure of the American and other families, sufficient affinities exist to make a common origin or early connexion extremely likely. The verbal affinities are also very considerable. Humboldt says, "In eighty-three American languages examined by Messrs. Barton and Vater, one hundred and seventy words have been found, the roots of which appear to be the same; and it is easy to perceive that this analogy is not accidental, since it does not rest merely upon imitative harmony, or on that conformity of organs which produces almost a perfect identity in the first sounds articulated by children. Of these one hundred and seventy words which have this connexion, three-fifths resemble the Manchou, the Tongouse, the Mongal, and the Samoyed; and two-fifths, the Celtic and Tchoud, the Biscayan, the Coptic, and Congo languages. These words have been found by comparing the whole of the American languages with the whole of those of the Old World; for hitherto we are acquainted with no American idiom which seems to have an exclusive correspondence with any of the Asiatic, African, or European tongues."* Humboldt and others con-

* Views of the Cordilleras.

sidered these words as brought into America by recent immigrants; an idea resting on no proof, and which seems at once refuted by the common words being chiefly those which represent primary ideas; besides, we now know, what was not formerly perceived or admitted, that there are great affinities of structure also. I may here refer to a curious mathematical calculation by Dr. Thomas Young, to the effect, that if three words coincide in two different languages, it is ten to one they must be derived in both cases from some parent language, or introduced in some other manner. "Six words would give more," he says, "than seventeen hundred to one, and eight near 100,000, so that in these cases the evidence would be little short of absolute certainty." He instances the following words to shew a connexion between the ancient Egyptian and the Biscayan:—

	Biscayan.	Egyptian.
New	Beria	Beri.
A dog	Ora	Whor.
Little	Gutchi	Kudchi.
Bread	Ognia	Oik.
A wolf	Otgsa	Ounsh.
Seven	Shashpi	Shashf.

Now, as there are, according to Humboldt, one hundred and seventy words in common between

the languages of the new and old continents, and many of these are expressive of the most primitive ideas, there is, by Dr. Young's calculation, overpowering proof of the original connexion of the American and other human families.

This completes the slight outline which I have been able to give, of the evidence for the various races of men being descended from one stock. It cannot be considered as conclusive, and there are many eminent persons who deem the opposite idea the more probable; but I must say that, without the least regard to any other kind of evidence, that which physiology and philology present seems to me decidedly favourable to the idea of one local origin.

Supposing the human race to be *one*, we are next called upon to inquire in what part of the earth it may most probably be supposed to have originated. One obvious mode of approximating to a solution of this question is to trace backward the lines in which the principal tribes appear to have migrated, and to see if these converge nearly to a point. It is very remarkable that the lines do converge, and are concentrated about the region of Hindostan. The language, religion, modes of reckoning time, and some other peculiar ideas of

the Americans, are now believed to refer their origin to North-Eastern Asia. Trace them farther back in the same direction, and we come to the north of India. The history of the Celts and Teutones represents them as coming from the east, the one after the other, successive waves of a tide of population flowing towards the north-west of Europe: this line being also traced back, rests finally at the same place. So does the line of Iranian population, which has peopled the east and south shores of the Mediterranean, Syria, Arabia, and Egypt. The Malay variety, again, rests its limit in one direction on the borders of India. Standing on that point, it is easy to see how the human family, originating there, might spread out in different directions, passing into varieties of aspect and of language as they spread, the Malay variety proceeding towards the Oceanic region, the Mongolians to the east and north, and sending off the red men as a sub-variety, the European population going off to the north-westward, and the Syrian, Arabian, and Egyptian, towards the countries which they are known to have so long occupied. The Negro alone is here unaccounted for; and of that race it may fairly be said, that it is the one most likely to have had an independent

origin, seeing that it is a type so peculiar in an inveterate black colour, and so humble in development. The ancient traditions of the human race exhibit an agreement with this view of its origin. There is one among the Hindoos which places the cradle of the human family in Thibet; another makes Ceylon the residence of the first man. The development hypothesis would demand, of course, that the original seat of the human race should be in a region where the quadrumana are rife. Now these are most abundant, both in species and individuals, in the Indian archipelago, although it now appears, from the investigations of Professor Owen, that the chimpanzee of Western Africa approaches nearer to man than any known species of Indian simiæ.

After all, it may be regarded as still an open question, whether mankind is of one or more origins. The first human generation may have consisted of many pairs, though situated at one place, and these may have been considerably different from each other in external characters. And we are equally bound to admit, though this does not as yet seem to have occurred to any other speculator, that, barring any objection of a philological nature, there may have been at least one

other line or source of origination—shall we say in Africa, which resulted in the production of a being identical in species, although variously marked.

It has of late years been a favourite notion with several writers, that the human race was at first in a highly civilized state, and that barbarism was a second condition. The principal argument for it is, that we see many examples of nations falling away from civilization into barbarism, while, in some regions of the earth, the history of which we do not clearly know, there are remains of works of art far superior to any which the present unenlightened inhabitants could have produced. It is to be readily admitted that such decadences are common; but do they necessarily prove that there has been anything like a regular and constant decline into the present state, from a state more generally refined? May not these be only instances of local failures and suppressions of the principle of civilization, where it had begun to take root amongst a people generally barbarous? This, at least, were as legitimate an inference from the facts which are known. But it is also alleged that we know of no such thing as civilization being ever self-originated. It is always seen to be imparted from one people to another. Hence, of course, we must infer that civilization at the

first could only have been of supernatural origin. This argument appears to be founded on false premises, for civilization does sometimes rise in a manner clearly independent amongst a horde of people generally barbarous. A striking instance is described in the laborious work of Mr. Catlin on the North-American tribes. Far placed among those which inhabit the vast region of the north-west, and quite beyond the reach of any influence from the whites, he found a small tribe living in a fortified village, where they cultivated the arts of manufacture, realized comforts and luxuries, and had attained to a remarkable refinement of manners, insomuch as to be generally called "the polite and friendly Mandans." They were also more than usually elegant in their persons, and of every variety of complexion between that of their compatriots and a pure white. Up to the time of Mr. Catlin's visit, these people had been able to defend themselves and their possessions against the roving bands which surrounded them on all sides; but, soon after, they were attacked by small-pox, which cut them all off except a small party, whom their enemies rushed in upon and destroyed to a man. What is this but a repetition on a small scale of phenomena with which ancient history familiarizes us—a nation rising in arts and

elegances amidst barbarous neighbours, but at length overpowered by the rude majority, leaving only a Tadmor or a Luxor as a monument of itself to beautify the waste? What can we suppose the nation which built Palenque and Copan to have been but only a kind of Mandan tribe, which chanced to have made its way farther along the path of civilization and the arts, before the barbarians broke in upon it? The flame essayed to rise in many parts of the earth; but there were considerable agencies working against it, and down it accordingly went, times without number; yet there was always a vitality in it, nevertheless, and a tendency to progress, and at length it seems to have attained a strength against which the powers of barbarism can never more prevail. The state of our knowledge of uncivilized nations is very apt to make us fall into error on this subject. They are generally supposed to be all at one point in barbarism, which is far from being the case, for in the midst of every great region of uncivilized men, such as North America, there are nations partially refined. The Jolofs, Mandingoes, and Kafirs, are African examples, where a natural and independent origin for the improvement which exists is as unavoidably to be presumed as in the case of the Mandans.

The most conclusive argument against the original civilization of mankind is to be found in the fact that we do not now see civilization existing anywhere except in certain conditions altogether different from any we can suppose to have existed at the commencement of our race. To have civilization, it is necessary that a people should be numerous and closely placed; that they should be fixed in their habitations, and safe from violent external and internal disturbance; that a considerable number of them should be exempt from the necessity of drudging for immediate subsistence. Feeling themselves at ease about the first necessities of their nature, including self-preservation, and daily subjected to that intellectual excitement which society produces, men begin to manifest what is called civilization; but never in rude and shelterless circumstances, or when widely scattered. Even men who have been civilized, when transferred to a wide wilderness, where each has to work hard and isolatedly for the first requisites of life, soon shew a retrogression to barbarism: witness the plains of Australia, as well as the backwoods of Canada and the prairies of Texas. Fixity of residence and thickening of population are perhaps the prime requisites for civilization, and hence it will be found that all civilizations as

yet known have taken place in regions physically limited. That of Egypt arose in a narrow valley hemmed in by deserts on both sides. That of Greece took its rise in a small peninsula bounded on the only land side by mountains. Etruria and Rome were naturally limited regions. Civilizations have taken place at both the eastern and western extremities of the elder continent—China and Japan, on the one hand; Germany, Holland, Britain, France, on the other—while the great unmarked tract between contains nations decidedly less advanced. Why is this, but because the sea, in both cases, has imposed limits to further migration, and caused the population to settle and condense—the conditions most necessary for social improvement.* Even the simple case of the Mandans affords an illustration of this principle, for Mr. Catlin expressly, though without the least regard to theory, attributes their improvement to the fact of their being a small tribe, obliged, by fear of their more numerous enemies, to *settle in a permanent village*, so fortified as to ensure their pre-

* The problem of Chinese civilization, such as it is—so puzzling when we consider that they are only, as will be presently seen, the child race of mankind—is solved when we look to geographical position producing fixity of residence and density of population.

servation. "By this means," says he, "they have advanced farther in the arts of manufacture, and have supplied their lodges more abundantly with the comforts and even luxuries of life than any Indian nation I know of. The consequence of this," he adds, "is, that the tribe have taken many steps ahead of other tribes in *manners and refinements.*" These conditions can only be regarded as natural laws affecting civilization, and it might not be difficult, taking them into account, to predict of any newly settled country its social destiny. An island like Van Dieman's land might fairly be expected to go on more rapidly to good manners and sound institutions than a wide region like Australia. The United States might be expected to make no great way in civilization till they be fully peopled to the Pacific; and it might not be unreasonable to expect that, when that event has occurred, the greatest civilizations of that vast territory will be found in the peninsula of California and the narrow stripe of country beyond the Rocky Mountains. This, however, is a digression. To return: it is also necessary for a civilization that at least a portion of the community should be placed above mean and engrossing toils. Man's mind is subdued, like the dyer's hand,

to that it works in. In rude and difficult circumstances, we unavoidably become rude, because then only the inferior and harsher faculties of our nature are called into exercise. When, on the contrary, there is leisure and abundance, the self-seeking and self-preserving instincts are allowed to rest, the gentler and more generous sentiments are evoked, and man becomes that courteous and chivalric being which he is found to be amongst the upper classes of almost all civilized countries. These, then, may be said to be the chief natural laws concerned in the moral phenomenon of civilization. If I am right in so considering them, it will of course be readily admitted that the earliest families of the human race, although they might be simple and innocent, could not have been in anything like a civilized state, seeing that the conditions necessary for that state could not have then existed. Let us only for a moment consider some of the things requisite for their being civilized,—namely, a set of elegant homes ready furnished for their reception, fields ready cultivated to yield them food without labour, stores of luxurious appliances of all kinds, a complete social enginery for the securing of life and property,—and we shall turn from the whole

conceit as one worthy only of the philosophers of Utopia.

Yet, as has been remarked, the earliest families might be simple and innocent, while at the same time unskilled and ignorant, and obliged to live merely upon such substances as they could readily procure. The traditions of all nations refer to such a state as that in which mankind were at first: perhaps it is not so much a tradition as an idea which the human mind naturally inclines to form respecting the fathers of the race; but nothing that we see of mankind absolutely forbids our entertaining this idea, while there are some considerations rather favourable to it. A few families, in a state of nature, living near each other, in a country supplying the means of livelihood abundantly, are generally simple and innocent; their instinctive and perceptive faculties are also apt to be very active, although the higher intellect may be dormant. If we therefore presume India to have been the cradle of our race, they might at first exemplify a kind of golden age; but it could not be of long continuance. The very first movements from the primal seat would be attended with deterioration, nor could there be any tendency to true civilization till groups had

settled and thickened in particular seats physically limited.

The causes of the various external peculiarities of mankind now require some attention. Why, it is asked, are the Africans black, and generally marked by ungainly forms; why the flat features of the Chinese, and the comparatively well-formed figures of the Caucasians? Why the Mongolians generally yellow, the Americans red, and the Caucasians white? These questions were complete puzzles to all early writers; but physiology has lately thrown a great light upon them. It is now shewn that the brain, after completing the series of animal transformations, passes through the characters in which it appears in the Negro, Malay, American, and Mongolian nations, and finally becomes Caucasian. The face partakes of these alterations. "One of the earliest points in which ossification commences is the lower jaw. This bone is consequently sooner completed than the other bones of the head, and acquires a predominance, which, as is well known, it never loses in the Negro. During the soft pliant state of the bones of the skull, the oblong form which they naturally assume, approaches nearly the permanent shape of the Americans. At birth, the flattened

face, and broad smooth forehead of the infant, the position of the eyes rather towards the side of the head, and the widened space between, represent the Mongolian form; while it is only as the child advances to maturity, that the oval face, the arched forehead, and the marked features of the true Caucasian, become perfectly developed."* *The leading characters, in short, of the various races of mankind, are simply representations of particular stages in the development of the highest or Caucasian type.* The Negro exhibits permanently the imperfect brain, projecting lower jaw, and slender bent limbs, of a Caucasian child, some considerable time before the period of its birth. The aboriginal American represents the same child nearer birth. The Mongolian is an arrested infant newly born. And so forth. All this is as respects form;† but whence colour? This might be supposed to have depended on climatal agencies only; but it has been shewn by overpowering evidence to be independent of these. In further considering the matter, we are met by the very remarkable fact

* Lord's Popular Physiology, explaining observations by M. Serres.

† Conformably to this view, the beard, that peculiar attribute of maturity, is scanty in the Mongolian, and scarcely exists in the Americans and Negroes.

that colour is deepest in the least perfectly developed type, next in the Malay, next in the American, next in the Mongolian, the very order in which the degrees of development are ranged. *May not colour, then, depend upon development also?* We do not, indeed, see that a Caucasian fœtus at the stage which the African represents is anything like black; neither is a Caucasian child yellow, like the Mongolian. But the case of a Caucasian fœtus, or child, at any of its stages of development, is different from that of a being whose *mature form* only comes up to the same point. When a being is presented, who at full time has only attained a point of formation such as the Caucasian passed at a comparatively early stage of his embryotic history, there may be a character of skin liable to a certain tinting on being exposed. Development being arrested at so immature a stage in the case of the Negro, the skin may take on the colour as an unavoidable consequence of its imperfect organization. It is favourable to this view, that Negro infants are not deeply black at first, but only acquire the full colour tint after exposure for some time to the atmosphere; also that the parts of the body concealed by clothing are not generally of so deep a hue as the face and hands. The phenomenon,

in short, appears identical in character with the photographic process; not a result of the action of heat, as has been so long blunderingly supposed, but of light! It takes its place under the infant science of actino-chemistry, to which, perhaps, many other remarkable phenomena connected with the natural history of our race will yet be referred. This view, it must be admitted, is favourable to the doctrine of one origin for the human family. It seems to account for all the varieties as only the result of so many advances and retrogressions, or the one or the other exclusively, in the developing power of the human mothers.

We have seen that the traces of a common origin in all languages afford a ground of presumption for the unity of the human race. They establish a still stronger probability that mankind had not yet begun to disperse before they were possessed of a means of communicating their ideas by conventional sounds—in short, speech. This is a gift so peculiar to man, and in itself so remarkable, that there is a great inclination to surmise a miraculous origin for it, although there is no proper ground, or even support, for such an idea in Scripture, while it is clearly opposed to everything else we know with regard to the providential arrange-

ments for the creation of our race. Here, as in many other cases, a little observation of nature might have saved much vain discussion. The real character of language itself has not been thoroughly understood. Language, in its most comprehensive sense, is the communication of ideas by whatever means. Ideas can be communicated by looks, gestures, and signs of various other kinds, as well as by speech. The inferior animals possess some of those means of communicating ideas, and they have likewise a silent and unobservable mode of their own, the nature of which is a complete mystery to us, though we are assured of its reality by its effects. Now, as the inferior animals were all in being before man, there was language upon earth long ere the history of our race commenced. The only additional fact in the history of language, which was produced by our creation, was the rise of a new mode of expression—namely, that by *sound-signs* produced by the vocal organs. In other words, speech was the only novelty in this respect attending the creation of the human race. No doubt it was an addition of great importance, for, in comparison with it, the other natural modes of communicating ideas are insignificant. Still, the main and funda-

mental phenomenon, language, as the communication of ideas, was no new gift of the Creator to man; and in speech itself, when we judge of it as a natural fact, we see only a result of some of those superior endowments of which so many others have fallen to our lot through the medium of a superior organization.

The first and most obvious natural endowment concerned in speech is that peculiar organization of the larynx, trachea, and mouth, which enables us to produce the various sounds required. Man started at first with this organization ready for use, a constitution of the atmosphere adapted for the sounds which that organization was calculated to produce, and, lastly, but not leastly, as will afterwards be more particularly shewn, a mental power within, prompting to, and giving directions for, the expression of ideas. Such an arrangement of mutually adapted things was as likely to produce sounds as an Eolian harp placed in a draught is to produce tones. It was unavoidable that human beings so organized, and in such a relation to external nature, should utter sounds, and also come to attach to these conventional meanings, thus forming the elements of spoken language. The great difficulty which has been felt was to account

for man going in this respect beyond the inferior animals. There could have been no such difficulty if speculators in this class of subjects had looked into physiology for an account of the superior vocal organization of man, and had they possessed a true science of mind to shew man possessing a faculty for the expression of ideas which is only rudimental in the lower animals. Another difficulty has been in the consideration that, if men were at first utterly untutored and barbarous, they could scarcely be in a condition to form or employ language—an instrument which it requires the fullest powers of thought to analyze and speculate upon. But this difficulty also vanishes upon reflection—for, in the first place, we are not bound to suppose the fathers of our race early attaining to great proficiency in language, and, in the second, language itself seems to be amongst the things least difficult to be acquired, if we can form any judgment from what we see in children, most of whom have, by three years of age, while their information and judgment are still as nothing, mastered and familiarized themselves with a quantity of words, infinitely exceeding in proportion what they acquire in the course of any subsequent similar portion of time.

Discussions as to which parts of speech were

first formed, and the processes by which grammatical structure and inflections took their rise, appear in a great measure needless, after the matter has been placed in this light. The mental powers could readily connect particular arbitrary sounds with particular ideas, whether those ideas were nouns, verbs, or interjections. As the words of all languages can be traced back into roots which are monosyllables, we may presume these sounds to have all been monosyllabic accordingly. The clustering of two or more together to express a compound idea, and the formation of inflections by additional syllables expressive of pronouns and such prepositions as of, by, and to, are processes which would or might occur as matters of course, being simple results of a mental power called into action, and partly directed, by external necessities. This power, however, as we find it in very different degrees of endowment in individuals, so would it be in different degrees of endowment in nations, or branches of the human family. Hence we find the formation of words and the process of their composition and grammatical arrangement, in very different stages of development in different races. The Chinese have a language composed of a limited number of monosyllables, which they

multiply in use by mere variations of accent, and which they have never yet attained the power of clustering or inflecting; the language of this immense nation — the third part of the human race — may be said to be in the condition of infancy. The aboriginal Americans, so inferior in civilization, have, on the other hand, a language of the most elaborately composite kind, perhaps even exceeding, in this respect, the languages of the most refined European nations. These are but a few out of many facts tending to shew that language is in a great measure independent of civilization, as far as its advance and development are concerned. Do they not also help to prove that cultivated intellect is not necessary for the origination of language?

Facts daily presented to our observation afford equally simple reasons for the almost infinite diversification of language. It is invariably found that, wherever society is at once dense and refined, language tends to be uniform throughout the whole population, and to undergo few changes in the course of time. Wherever, on the contrary, we have a scattered and barbarous people, we have great diversities, and comparatively rapid alterations of language. Insomuch that, while English,

French, and German are each spoken with little variation by many millions, there are islands in the Indian archipelago, probably not inhabited by one million, but in which there are hundreds of languages, as diverse as are English, French, and German. It is easy to see how this should be. There are peculiarities in the vocal organization of every person, tending to produce peculiarities of pronunciation; for example, it has been stated that each child in a family of six gave the monosyllable, fly, in a different manner, (eye, fy, ly, &c.) until, when the organs were more advanced, correct example induced the proper pronunciation of this and similar words. Such departures from orthoepy are only to be checked by the power of such example; but this is a power not always present, or not always of sufficient strength. The self-devoted Robert Moffat, in his work on South Africa, states, without the least regard to hypothesis, that amongst the people of the towns of that great region, "the purity and harmony of language is kept up by their pitchos or public meetings, by their festivals and ceremonies, as well as by their songs and their constant intercourse. With the isolated villages of the desert, it is far otherwise. They have no such meetings; they are compelled to traverse the wilds,

often to a great distance from their native village. On such occasions, fathers and mothers, and all who can bear a burden, often set out for weeks at a time, and leave their children to the care of two or three infirm old people. The infant progeny, some of whom are beginning to lisp, while others can just master a whole sentence, and those still farther advanced, romping and playing together, the children of nature, through the live-long day, *become habituated to a language of their own.* The more voluble condescend to the less precocious, and thus, from this infant Babel, proceeds a dialect composed of a host of mongrel words and phrases, joined together without rule, and *in the course of a generation the entire character of the language is changed.*"* I have been told, that in like manner the children of the Manchester factory workers, left for a great part of the day, in large assemblages, under the care of perhaps a single elderly person, and spending the time in amusements, are found to make a great deal of new language. I have seen children in other circumstances amuse themselves by concocting and throwing into the family circulation entirely new words; and I believe I am running little risk of contradiction when I say that

* Missionary Scenes and Labours in South Africa.

there is scarcely a family, even amongst the middle classes of this country, who have not some peculiarities of pronunciation and syntax, which have originated amongst themselves, it is hardly possible to say how. All these things being considered, it is easy to understand how mankind have come at length to possess between three and four thousand languages, all different at least as much as French, German, and English, though, as has been shewn, the traces of a common origin are observable in them all.

What has been said on the question whether mankind were originally barbarous or civilized, will have prepared the reader for understanding how the arts and sciences, and the rudiments of civilization itself, took their rise amongst men. The only source of fallacious views on this subject is the so frequent observation of arts, sciences, and social modes, forms, and ideas, being not indigenous where we see them now flourishing, but known to have been derived elsewhere: thus Rome borrowed from Greece, Greece from Egypt, and Egypt itself, lost in the mists of historic antiquity, is now supposed to have obtained the light of knowledge from some still earlier scene of intellectual culture. This has caused to many a great

difficulty in supposing a natural or spontaneous origin for civilization and the attendant arts. But, in the first place, several stages of derivation are no conclusive argument against there having been an originality at some earlier stage. In the second, such observers have not looked far enough, for, if they had, they could have seen various instances of civilizations which it is impossible, with any plausibility, to trace back to a common origin with others; such are those of China and America. They would also have seen civilization springing up, as it were, like oases amongst the arid plains of barbarism, as in the case of the Mandans. A still more attentive study of the subject would have shewn, amongst living men, the very psychological procedure on which the origination of civilization and the arts and sciences depended.

These things, like language, are simply the effects of the spontaneous working of certain mental faculties, each in relation to the things of the external world on which it was intended by creative Providence to be exercised. The monkeys themselves, without instruction from any quarter, learn to use sticks in fighting, and some build houses—an act which cannot in their case be considered as one of instinct, but of intelligence.

Such being the case, there is no necessary difficulty in supposing how man, with his superior mental organization, (a brain five times heavier,) was able, in his primitive state, without instruction, to turn many things in nature to his use, and commence, in short, the circle of the domestic arts. He appears, in the most unfavourable circumstances, to be able to provide himself with some sort of dwelling, to make weapons, and to practise some simple kind of cookery. But, granting, it will be said, that he can go thus far, how does he ever proceed farther unprompted, seeing that many nations remain fixed for ever at this point, and seem unable to take one step in advance? It is perfectly true that there is such a fixation in many nations; but, on the other hand, all nations are not alike in mental organization, and another point has been established, that only when some favourable circumstances have settled a people in one place, do arts and social arrangements get leave to flourish. If we were to limit our view to humbly endowed nations, or the common class of minds in those called civilized, we should see absolutely no conceivable power for the origination of new ideas and devices. But let us look at the inventive class of minds which stand out amongst their

fellows—the men who, with little prompting or none, conceive new ideas in science, arts, morals—and we can be at no loss to understand how and whence have arisen the elements of that civilization which history traces from country to country throughout the course of centuries. See a Pascal, reproducing the Alexandrian's problems at fifteen; a Ferguson, making clocks from the suggestions of his own brain, while tending cattle on a Morayshire heath; a boy Lawrence, in an inn on the Bath road, producing, without a master, drawings which the educated could not but admire; or look at Solon and Confucius, devising sage laws, and breathing the accents of all but divine wisdom, for their barbarous fellow-countrymen, three thousand years ago—and the whole mystery is solved at once. Amongst the arrangements of Providence is one for the production of original, inventive, and aspiring minds, which, when circumstances are not decidedly unfavourable, strike out new ideas for the benefit of their fellow-creatures, or put upon them a lasting impress of their own superior sentiments. Nations, improved by these means, become in turn *foci* for the diffusion of light over the adjacent regions of barbarism—their very passions helping to this end, for nothing can

be more clear than that ambitious aggression has led to the civilization of many countries. Such is the process which seems to form the destined means for bringing mankind from the darkness of barbarism to the day of knowledge and mechanical and social improvement. Even the noble art of letters is but, as Dr. Adam Fergusson has remarked, "a natural produce of the human mind, which will rise spontaneously, wherever men are happily placed;" original alike amongst the ancient Egyptians and the dimly monumented Toltecans of Yucatan. "Banish," says Dr. Gall, "music, poetry, painting, sculpture, architecture, all the arts and sciences, and let your Homers, Raphaels, Michael Angelos, Glucks, and Canovas, be forgotten, yet let men of genius of every description spring up, and poetry, music, painting, architecture, sculpture, and all the arts and sciences, will again shine out in all their glory. Twice within the records of history has the human race traversed the great circle of its entire destiny, and twice has the rudeness of barbarism been followed by a higher degree of refinement. It is a great mistake to suppose one people to have proceeded from another on account of their conformity of manners, customs, and arts. The swallow of Paris builds

its nest like the swallow of Vienna, but does it thence follow that the former sprung from the latter? With the same causes we have the same effects; with the same organization we have the manifestation of the same powers."

MENTAL CONSTITUTION OF ANIMALS.

It has been one of the most agreeable tasks of modern science to trace the wonderfully exact adaptations of the organization of animals to the physical circumstances amidst which they are destined to live. From the mandibles of insects to the hand of man, all is seen to be in the most harmonious relation to the things of the outward world, thus clearly proving that *design* presided in the creation of the whole—design again implying a designer, another word for a CREATOR.

It would be tiresome to present in this place even a selection of the proofs which have been adduced on this point. The Natural Theology of Paley, and the Bridgewater Treatises, place the subject in so clear a light, that the general postulate may be taken for granted. The physical

constitution of animals is, then, to be regarded as in the nicest congruity and adaptation to the external world.

Less clear ideas have hitherto been entertained on the mental constitution of animals. The very nature of this constitution is not as yet generally known or held as ascertained. There is, indeed, a notion of old standing, that the mind is in some way connected with the brain; but the metaphysicians insist that it is, in reality, known only by its acts or effects, and they accordingly present the subject in a form which is unlike any other kind of science, for it does not so much as pretend to have nature for its basis. There is a general disinclination to regard mind in connexion with organization, from a fear that this must needs interfere with the cherished religious doctrine of the spirit of man, and lower him to the level of the brutes. A distinction is therefore drawn between our mental manifestations and those of the lower animals, the latter being comprehended under the term instinct, while ours are collectively described as mind, mind being again a received synonyme with soul, the immortal part of man. There is here a strange system of confusion and error, which it is most imprudent to regard as

essential to religion, since candid investigations of nature tend to shew its untenableness. There is, in reality, nothing to prevent our regarding man as specially endowed with an immortal spirit, at the same time that his ordinary mental manifestations are looked upon as simple phenomena resulting from organization, those of the lower animals being phenomena absolutely the same in character, though developed within narrower limits.*

* "Is not God the first cause of matter as well as of mind? Do not the first attributes of matter lie as inscrutable in the bosom of God—of its first author—as those of mind? Has not even matter confessedly received from God the power of experiencing, in consequence of impressions from the earlier modifications of matter, certain consciousnesses called sensations of the same? Is not, therefore, the wonder of matter also receiving the consciousnesses of other matter called ideas of the mind a wonder more flowing out of and in analogy with all former wonders, than would be, on the contrary, the wonder of this faculty of the mind not flowing out of any faculties of matter? Is it not a wonder which, so far from destroying our hopes of immortality, can establish that doctrine on a train of inferences and inductions more firmly established and more connected with each other than the former belief can be, as soon as we have proved that matter is not perishable, but is only liable to successive combinations and decombinations?

"Can we look farther back one way into the first origin of matter than we can look forward the other way into the last developments of mind? Can we say that God has not in matter itself laid the seeds of every faculty of mind, rather than that he

What has chiefly tended to take mind, in the eyes of learned and unlearned, out of the range of nature, is its apparently irregular and wayward character. How different the manifestations in different beings! how unstable in all!—at one time so calm, at another so wild and impulsive! It seemed impossible that anything so subtle and aberrant could be part of a system, the main features of which are regularity and precision. But the irregularity of mental phenomena is only in appearance. When we give up the individual, and take the mass, we find as much uniformity of

has made the first principle of mind entirely distinct from that of matter? Cannot the first cause of all we see and know have *fraught matter itself, from its very beginning, with all the attributes necessary to develop into mind,* as well as he can have from the first made the attributes of mind wholly different from those of matter, only in order afterwards, by an imperceptible and incomprehensible link, to join the two together?

" * * [The decombination of the matter on which mind rests] is this a reason why mind must be annihilated? Is the temporary reverting of the mind, and of the sense out of which that mind develops, to their original component elements, a reason for thinking that they cannot again at another later period and in another higher globe, be again recombined, and with more splendour than before? * * The New Testament does not after death here promise us a soul hereafter unconnected with matter, and which has no connexion with our present mind—a soul independent of time and space. That is a fanciful idea, not founded on its expressions, when taken in their just and real

result as in any other class of natural phenomena. The irregularity is exactly of the same kind as that of the weather. No man can say what may be the weather of to-morrow; but the quantity of rain which falls in any particular place in any five years is precisely the same as the quantity which falls in any other five years at the same place. Thus, while it is absolutely impossible to predict of any one Frenchman that during next year he will commit a crime, it is quite certain that about one in every six hundred and fifty of the French

meaning. On the contrary, it promises us a mind like the present, founded on time and space; since it is, like the present, to hold a certain situation in time, and a certain locality in space: but it promises a mind situated in portions of time and of space different from the present: a mind composed of elements of matter more extended, more perfect, and more glorious: a mind which, formed of materials supplied by different globes, is consequently able to see farther into the past, and to think farther into the future, than any mind here existing: a mind which, freed from the partial and uneven combination incidental to it on this globe, will be exempt from the changes for evil to which, on the present globe, mind as well as matter is liable, and will only thenceforth experience the changes for the better which matter, more justly poised, will alone continue to experience: a mind which, no longer fearing the death, the total decomposition, to which it is subject on this globe, will thenceforth continue last and immortal." — HOPE, *on the Origin and Prospects of Man*, 1831.

people will do so, because in past years the proportion has generally been about that amount, the tendencies to crime in relation to the temptations being everywhere invariable over a sufficiently wide range of time. So also, the number of persons taken in charge by the police in London for being drunk and disorderly in the streets, is, week by week, a nearly uniform quantity, shewing that the inclination to drink to excess is always in the mass about the same, regard being had to the existing temptations or stimulations to this vice. Even mistakes and oversights are of regular recurrence, for it is found in the post-offices of large cities, that the number of letters put in without addresses is year by year the same. Statistics has made out an equally distinct regularity in a wide range, with regard to many other things concerning the mind, and the doctrine founded upon it has lately produced a scheme which may well strike the ignorant with surprise. It was proposed to establish in London a society for ensuring the integrity of clerks, secretaries, collectors, and all such functionaries as are usually obliged to find security for money passing through their hands in the course of business. A gentleman of the highest character as an actuary spoke of the plan in the

following terms:—"If a thousand bankers' clerks were to club together to indemnify their securities, by the payment of one pound a year each, and if each had given security for 500*l.*, it is obvious that two in each year might become defaulters to that amount, four to half the amount, and so on, without rendering the guarantee fund insolvent. If it be tolerably well ascertained that the instances of dishonesty (yearly) among such persons amount to one in five hundred, this club would continue to exist, subject to being in debt in a bad year, to an amount which it would be able to discharge in good ones. The only question necessary to be asked previous to the formation of such a club would be,—may it not be feared that the motive to resist dishonesty would be lessened by the existence of the club, or that ready-made rogues, by belonging to it, might find the means of obtaining situations which they would otherwise have been kept out of by the impossibility of obtaining security among those who know them? Suppose this be sufficiently answered by saying, that none but those who could bring satisfactory testimony to their previous good character should be allowed to join the club; that persons who may now hope that a deficiency on their parts will be made up and

hushed up by the relative or friend who is security, will know very well that the club will have no motive to decline a prosecution, or to keep the secret, and so on. It then only remains to ask, whether the sum demanded for the guarantee is sufficient?"* The philosophical principle on which the scheme proceeds, seems to be simply this, that amongst a given (large) number of persons of good character, there will be, within a year or other considerable space of time, a determinate number of instances in which moral principle and the terror of the consequences of guilt will be overcome by temptations of a determinate kind and amount, and thus occasion a certain periodical amount of loss which the association must make up.

This statistical regularity in moral affairs fully establishes their being under the presidency of law. Man is now seen to be an enigma only as an individual; in the mass he is a mathematical problem. It is hardly necessary to say, much less to argue, that mental action, being proved to be under law, passes at once into the category of natural things. Its old metaphysical character vanishes in a mo-

* Dublin Review, Aug. 1840. The Guarantee Society has since been established, and is likely to become a useful and prosperous institution.

ment, and the distinction usually taken between physical and moral is annulled. This view agrees with what all observation teaches, that mental phenomena flow directly from the brain. They are seen to be dependent on naturally constituted and naturally conditioned organs, and thus obedient, like all other organic phenomena, to law. And how wondrous must the constitution of this apparatus be, which gives us consciousness of thought and of affection, which makes us familiar with the numberless things of earth, and enables us to rise in conception and communion to the councils of God himself! It is matter which forms the medium or instrument—a little mass which, decomposed, is but so much common dust; yet in its living constitution, designed, formed, and sustained by Almighty Wisdom, how admirable its character! how reflective of the unutterable depths of that Power by which it was so formed, and is so sustained!

In the mundane economy, mental action takes its place as a means of providing for the independent existence and the various relations of animals, each species being furnished according to its special necessities and the demands of its various relations. The nervous system—the more comprehensive term

for its organic apparatus—is variously developed in different classes and species, and also in different individuals, the volume or mass bearing a general relation to the amount of power. Passing over the humblest orders, where nervous apparatus is so obscure as hardly to be traceable, we see it in the nematoneura of Owen* in filaments and nuclei, the mere rudiments of the system. In the articulata, it is advanced to a double nervous cord, with ganglia or little masses of nervous matter at frequent intervals, and filaments branching out towards each side; the ganglia near the head being apparently those which send out nerves to the organs of the senses; and this arrangement is only less symmetrical in the mollusca. Ascending to the vertebrata, we find a spinal cord, with a brain at the upper extremity, and numerous branching lines of nervous tissue,† an organization strikingly superior; yet here, as in the general structure of animals, the great principle of unity is observed. The brain of the vertebrata is merely an expansion

* Including rotifera, entozoa, echinodermata, &c.

† The ray, which is considered as low in the scale of fishes, and near to the crustaceans, gives the first faint representation of a brain in certain scanty and medullary masses, which appear as merely composed of enlarged origins of the nerves.

of the anterior pair of the ganglia of the articulata, or these ganglia may be regarded as the rudiment of a brain, the superior organ thus appearing as only a farther development of the inferior. There are many facts which tend to prove that the action of this apparatus is of an electric nature, a modification of that surprising agent, which takes magnetism, heat, and light, as other subordinate forms, and of whose general scope in this great system of things we are only beginning to have a right conception. It has been found that simple electricity, artificially produced, and sent along the nerves of a dead body, excites muscular action. The brain of a newly-killed animal being taken out, and replaced by a substance which produces electric action, the operation of digestion, which had been interrupted by the death of the animal, was resumed, shewing the absolute identity of the brain with a galvanic battery. Nor is this a very startling idea, when we reflect that electricity is almost as metaphysical as ever mind was supposed to be. It is a thing perfectly intangible, weightless. A mass of metal may be magnetized, or heated to seven hundred of Fahrenheit, without becoming the hundredth part of a grain heavier. And yet electricity is a real thing, an actual existence in

nature, as witness the effects of heat and light in vegetation—the power of the galvanic current to re-assemble the particles of copper from a solution, and make them again into a solid plate — the rending force of the thunderbolt as it strikes the oak. See also how both heat and light observe the angle of incidence in reflection, as exactly as does the grossest stone thrown obliquely against a wall. So mental action may be imponderable, intangible, and yet a real existence, and ruled by the Eternal through his laws.*

Common observation shews a great general superiority of the human mind over that of the inferior animals. Man's mind is almost infinite in device; it ranges over all the world; it forms the most wonderful combinations; it seeks back into

* If mental action is electric, the proverbial quickness of thought—that is, the quickness of the transmission of sensation and will—may be presumed to have been brought to an exact measurement. The speed of light has long been known to be about 192,000 miles per second, and the experiments of Wheatstone have shewn that the electric agent travels (if I may so speak) at the same rate, thus shewing a likelihood that one law rules the movements of all the "imponderable bodies." Mental action may accordingly be presumed to have a rapidity equal to one hundred and ninety-two thousand miles in the second—a rate evidently far beyond what is necessary to make the design and execution of any of our ordinary muscular movements apparently identical in point of time, which they are.

the past, and stretches forward into the future; while the animals generally appear to have a narrow range of thought and action. But so also has an infant but a limited range, and yet it is mind which works there, as well as in the most accomplished adults. The difference between mind in the lower animals and in man is a difference in degree only; it is not a specific difference. All who have studied animals by actual observation, and even those who have given a candid attention to the subject in books, must attain more or less clear convictions of this truth, notwithstanding all the obscurity which prejudice may have engendered. We see animals capable of affection, jealousy, envy; we see them quarrel, and conduct quarrels in the very manner pursued by the ruder and less educated of our own race. We see them liable to flattery, inflated with pride, and dejected by shame. We see them as tender to their young as human parents are, and as faithful to a trust as the most conscientious of human servants. The horse is startled by marvellous objects, as a man is. The dog and many others shew tenacious memory. The dog also proves himself possessed of imagination, by the act of dreaming. Horses finding themselves in want of a shoe,

have of their own accord gone to a farrier's shop where they were shod before. Cats, closed up in rooms, will endeavour to obtain their liberation by pulling a latch or ringing a bell. It has several times been observed that in a field of cattle, when one or two were mischievous, and persisted long in annoying or tyrannizing over the rest, the herd, to all appearance, consulted, and then, making a united effort, drove the troublers off the ground. The members of a rookery have also been observed to take turns in supplying the needs of a family reduced to orphanhood. All of these are acts of reason, in no respect different from similar acts of men. Moreover, although there is no heritage of accumulated knowledge amongst the lower animals, as there is amongst us, they are in some degree susceptible of those modifications of natural character, and capable of those accomplishments, which we call education. The taming and domestication of animals, and the changes thus produced upon their nature in the course of generations, are results identical with civilization amongst ourselves; and the quiet, servile steer is probably as unlike the original wild cattle of this country, as the English gentleman of the present day is unlike the rude baron of the age of King

John. Between a young, unbroken horse, and a trained one, there is, again, all the difference which exists between a wild youth reared at his own discretion in the country, and the same person when he has been toned down by long exposure to the influences of refined society. On the accomplishments acquired by animals it were superfluous to enter at any length; but I may advert to the dogs of M. Leonard, as remarkable examples of what the animal intellect may be trained to. When four pieces of card are laid down before them, each having a number pronounced *once* in connexion with it, they will, after a re-arrangement of the pieces, select any one named by its number. They also play at dominoes, and with so much skill as to triumph over biped opponents, whining if the adversary plays a wrong piece, or if they themselves be deficient in a right one. Of extensive combinations of thought we have no reason to believe that any animal is capable—and yet most of us must feel the force of Walter Scott's remark, that there was scarcely anything which he would not believe of a dog. There is a curious result of education in certain animals, namely, that habits to which they have been trained in some instances become hereditary. For example, the accomplish-

ment of pointing at game, although a pure result of education, appears in the young pups brought up apart from their parents and kind. The peculiar leap of the Irish horse, acquired in the course of traversing a boggy country, is continued in the progeny brought up in England. This hereditariness of specific habits suggests a relation to that form of psychological demonstration usually called instinct; but instinct is only another term for mind, or is mind in a peculiar stage of development; and though the fact were otherwise, it could not affect the postulate, that demonstrations such as have been enumerated are mainly intellectual demonstrations, not to be distinguished as such from those of human beings.

More than this, the lower animals manifested mental phenomena long before man existed. While as yet there was no brain capable of working out a mathematical problem, the economy of the six-sided figure was exemplified by the instinct of the bee. The dog and the elephant prefigured the sagacity of the human mind. The love of a human mother for her babe was anticipated by nearly every humbler mammal, the carnaria not excepted. The peacock strutted, the turkey blustered, and the cock fought for victory, just as

human beings afterwards did, and still do. Our faculty of imitation, on which so much of our amusement depends, was exercised by the mocking-bird; and the whole tribe of monkeys must have walked about the pre-human world, playing off those tricks in which we see the comicality and mischief-making of our character so curiously exaggerated.

The unity and simplicity which characterize nature give great antecedent probability to what observation seems about to establish, that, as the brain of the vertebrata generally is just an advanced condition of a particular ganglion in the mollusca and crustacea, so are the brains of the higher and more intelligent mammalia only farther developments of the brains of the inferior orders of the same class. Or, to the same purpose, it may be said, that each species has certain superior developments, according to its needs, while others are in a rudimental or repressed state. This will more clearly appear after some inquiry has been made into the various powers comprehended under the term mind.

One of the first and simplest functions of mind is to give *consciousness*—consciousness of our identity and of our existence. This, apparently,

is independent of the *senses*, which are simply media, and, as Locke has shewn, the only media, through which ideas respecting the external world reach the brain. The access of such ideas to the brain is the act to which the metaphysicians have given the name of perception. Gall, however, has shewn, by induction from a vast number of actual cases, that there is a part of the brain devoted to perception, and that even this is subdivided into portions which are respectively dedicated to the reception of different sets of ideas, as those of form, size, colour, weight, objects in their totality, events in their progress or occurrence, time, musical sounds, &c. The system of mind invented by this philosopher—the only one founded upon nature, or which even pretends to or admits of that necessary basis—shews a portion of the brain acting as a faculty of comic ideas, another of imitation, another of wonder, one for discriminating or observing differences, and another in which resides the power of tracing effects to causes. There are also parts of the brain for the sentimental part of our nature, or the affections, at the head of which stand the moral feelings of benevolence, conscientiousness, and veneration. Through these, man stands in relation to himself,

his fellow-men, the external world, and his God; and through these comes most of the happiness of man's life, as well as that which he derives from the contemplation of the world to come, and the cultivation of his relation to it, (pure religion.) The other sentiments may be briefly enumerated, their names being sufficient in general to denote their functions—firmness, hope, cautiousness, self-esteem, love of approbation, secretiveness, marvellousness, constructiveness, imitation, combativeness, destructiveness, concentrativeness, adhesiveness, love of the opposite sex, love of offspring, alimentiveness, and love of life. Through these faculties, man is connected with the external world, and supplied with active impulses to maintain his place in it as an individual and as a species. There is also a faculty, (language,) for expressing, by whatever means, (signs, gestures, looks, conventional terms in speech,) the ideas which arise in the mind. There is a particular state of each of these faculties, when the ideas of objects once formed by it are revived or reproduced, a process which seems to be intimately allied with some of the phenomena of the new science of photography, when images impressed by reflection of the sun's rays upon sensitive paper are, after a temporary

obliteration, resuscitated on the sheet being exposed to the fumes of mercury. Such are the phenomena of memory, that handmaid of intellect, without which there could be no accumulation of mental capital, but an universal and continual infancy. Conception and imagination appear to be only intensities, so to speak, of the state of brain in which memory is produced. On their promptness and power depend most of the exertions which distinguish the man of arts and letters, and even in no small measure the cultivator of science.

The faculties above described — the actual elements of the mental constitution — are seen in mature man in an indefinite potentiality and range of action. It is different with the lower animals. They are there comparatively definite in their power and restricted in their application. The reader is familiar with what are called instincts in some of the humbler species, that is, an uniform and unprompted tendency towards certain particular acts, as the building of cells by the bee, the storing of provisions by that insect and several others, and the construction of nests for a coming progeny by birds. This quality is nothing more than a mode of operation peculiar to the faculties

in a humble state of endowment, or early stage of development. The cell-formation of the bee, the house-building of ants and beavers, the web-spinning of spiders, are but primitive exercises of constructiveness, the faculty which, indefinite with us, leads to the arts of the weaver, upholsterer, architect, and mechanist, and makes us often work delightedly where our labours are in vain, or nearly so. The storing of provision by the bees is an exercise of acquisitiveness,—a faculty which with us makes rich men and misers. A vast number of curious devices, by which insects provide for the protection and subsistence of their young, whom they are perhaps never to see, are most probably a peculiar restricted effort of philoprogenitiveness. The common source of this class of acts, and of common mental operations, is shewn very convincingly by the melting of the one set into the other. Thus, for example, the bee and bird will make modifications in the ordinary form of their cells and nests when necessity compels them. Thus, the alimentiveness of such animals as the dog, usually definite with regard to quantity and quality, can be pampered or educated up to a kind of epicurism, that is, an indefiniteness of object and action. The same faculty acts limitedly

in ourselves at first, dictating the special act of sucking; afterwards it acquires indefiniteness. Such is the real nature of the distinction between what are called instinct and reason, upon which so many volumes have been written without profit to the world. All faculties are instinctive, that is, dependent on internal and inherent impulses. This term is therefore not specially applicable to either of the recognised modes of the operation of the faculties. We only, in the one case, see the faculty in an immature and slightly developed state; in the other, in its most advanced condition. In the one case it is *definite*, in the other, *indefinite*, in its range of action. These terms would perhaps be the most suitable for expressing the distinction.

In the humblest forms of being we can trace scarcely anything besides a definite action in a few of the faculties. Generally speaking, as we ascend in the scale, we see more and more of the faculties in exercise, and these tending more to the indefinite mode of manifestation. And for this there is the obvious reason in providence, that the lowest animals have all of them a very limited sphere of existence, born only to perform a few functions, and enjoy a brief term of life, and then

give way to another generation, so that they do not need much mental guidance. At higher points in the scale, the sphere of existence is considerably extended, and the mental operations are less definite accordingly. The horse, dog, and a few other animals, noted for their serviceableness to our race, have the indefinite powers in no small endowment. Man, again, shews very little of the definite mode of operation, and that little chiefly in childhood, or in barbarism, or idiocy. Destined for a wide field of action, and to be applicable to infinitely varied contingencies, he has all the faculties developed to a high pitch of indefiniteness, that he may be ready to act well in all imaginable cases. His commission, it may be said, gives large discretionary powers, while that of the inferior animals is limited to a few precise directions. But when the human brain is congenitally imperfect or diseased, or when it is in the state of infancy, we see in it an approach towards the character of the brains of some of the inferior animals. Dr. J. G. Davey states that he has frequently witnessed, among his patients at the Hanwell Lunatic Asylum, indications of a particular abnormal cerebration which forcibly re-

minded him of the specific healthy characteristics of animals lower in the scale of organization;* and every one must have observed how often the actions of children, especially in their moments of play, and where their selfish feelings are concerned, bear a resemblance to those of certain familiar animals.† Behold, then, the wonderful unity of the whole system. The grades of mind, like the forms of being, are mere stages of development. In the humbler forms, but a few of the mental faculties are traceable, just as we see in them but a few of the lineaments of universal structure. In man the system has arrived at its highest condition. The few gleams of reason, then, which we see in the lower animals, are precisely analogous to such a development of the fore-arm as we find in the paddle of the whale. Causality, comparison, and other of the nobler faculties, are in them *rudimental.*

Bound up as we thus are by an identity in the character of our mental organization with the

* Phrenological Journal, xv. 000.

† A pampered lap-dog, living where there is another of its own species, will hide any nice morsel which it cannot eat, under a rug, or in some other by-place, designing to enjoy it afterwards. I have seen children do the same thing.

lower animals, we are yet, it will be observed, strikingly distinguished from them by this great advance in development. We have faculties in full force and activity which the animals either possess not at all, or in so low and obscure a form as to be equivalent to non-existence. Now these parts of mind are those which connect us with the things that are not of this world. We have veneration, prompting us to the worship of the Deity, which the animals lack. We have hope, to carry us on in thought beyond the bounds of time. We have reason, to enable us to inquire into the character of the Great Father, and the relation of us, his humble creatures, towards him. We have conscientiousness and benevolence, by which we can in a faint and humble measure imitate, in our conduct, that which he exemplifies in the whole of his wondrous doings. Beyond this, mental science does not carry us in support of religion: the rest depends on evidence of a different kind. But it is surely much that we thus discover in nature a provision for things so important. The existence of faculties having a regard to such things is a good evidence that such things exist. The face of God is reflected in the organization of man, as a little pool reflects the glorious sun.

The affective or sentimental faculties are all of them liable to operate whenever appropriate objects or stimuli are presented, and this they do as irresistibly and unerringly as the tree sucks up moisture which it requires, with only this exception, that one faculty often interferes with the action of another, and operates instead by force of superior inherent strength or temporary activity. For example, alimentiveness may be in powerful operation with regard to its appropriate object, producing a keen appetite, and yet it may not act, in consequence of the more powerful operation of cautiousness, warning against evil consequences likely to ensue from the desired indulgence. This liability to flit from under the control of one feeling to the control of another, constitutes what is recognised as free will in man, being nothing more than a vicissitude in the supremacy of the faculties over each other.

It is a common mistake to suppose that the individuals of our own species are all of them formed with similar faculties—similar in power and tendency—and that education and the influence of circumstances produce all the differences which we observe. There is not, in the old systems of mental philosophy, any doctrine more opposite to the truth

than this. It is refuted at once by the great differences of intellectual tendency and moral disposition to be observed amongst a group of young children who have been all brought up in circumstances perfectly identical—even in twins, who have never been but in one place, under the charge of one nurse, attended to alike in all respects. The mental characters of individuals are inherently various, as the forms of their persons and the features of their faces are; and education and circumstances, though their influence is not to be despised, are incapable of entirely altering these characters, where they are strongly developed. That the original characters of mind are dependent on the volume of particular parts of the brain and the general quality of that viscus, is proved by induction from an extensive range of observations, the force of which must have been long since universally acknowledged but for the unpreparedness of mankind to admit a functional connexion between mind and body. The different mental characters of individuals may be presumed from analogy to depend on the same law of development which we have seen determining forms of being and the mental characters of particular species. This we may conceive as carrying for-

ward the intellectual powers and moral dispositions of some to a high pitch, repressing those of others at a moderate amount, and thus producing all the varieties which we see in our fellow-creatures. Thus a Cuvier and a Newton are but expansions of a clown, and the person emphatically called the wicked man, is one whose highest moral feelings are rudimental. Such differences are not confined to our species; they are only less strongly marked in many of the inferior animals. There are clever dogs and wicked horses, as well as clever men and wicked men; and education sharpens the talents, and in some degree regulates the dispositions of animals, as it does our own.

There is, nevertheless, a general adaptation of the mental constitution of man to the circumstances in which he lives, as there is between all the parts of nature to each other. The goods of the physical world are only to be realized by ingenuity and industrious exertion; behold, accordingly, an intellect full of device, and a fabric of the faculties which would go to pieces or destroy itself if it were not kept in constant occupation. Nature presents to us much that is sublime and beautiful: behold faculties which delight in contemplating these properties of hers, and in rising upon them,

as upon wings, to the presence of the Eternal. It is also a world of difficulties and perils, and see how a large portion of our species are endowed with vigorous powers which take a pleasure in meeting and overcoming difficulty and danger. Even that principle on which our faculties are constituted—a wide range of freedom in which to act for all various occasions—necessitates a resentful faculty, by which individuals may protect themselves from the undue and capricious exercise of each other's faculties, and thus preserve their individual rights. So also there is cautiousness, to give us a tendency to provide against the evils by which we may be assailed; and secretiveness, to enable us to conceal whatever, being divulged, would be offensive to others or injurious to ourselves,—a function which obviously has a certain legitimate range of action, however liable to be abused. The constitution of the mind generally points to a state of intimate relation of individuals towards society, towards the external world, and towards things above this world. No individual being is integral or independent; he is only part of an extensive piece of social mechanism. The inferior mind, full of rude energy and unregulated impulse, does not more require a superior nature

to act as its master and its mentor, than does the superior nature require to be surrounded by such rough elements on which to exercise its high endowments as a ruling and tutelary power. This relation of each to each produces a vast portion of the active business of life. It is easy to see that, if we were all alike in our moral tendencies, and all placed on a medium of perfect moderation in this respect, the world would be a scene of everlasting dulness and apathy. It requires the variety of individual constitution to give moral life to the scene.

The indefiniteness of the potentiality of the human faculties, and the complexity which thus attends their relations, lead unavoidably to occasional error. If we consider for a moment that there are not less than thirty such faculties, that they are each given in different proportions to different persons, that each is at the same time endowed with a wide discretion as to the force and frequency of its action, and that our neighbours, the world, and our connexions with something beyond it, are all exercising an ever-varying influence over us, we cannot be surprised at the irregularities attending human conduct. It is simply the penalty paid for the superior endowment. It

is here that the imperfection of our nature resides. Causality and conscientiousness are, it is true, guides over all; but even these are only faculties of the same indeterminate constitution as the rest, and partake accordingly of the same inequality of action. Man is therefore a piece of mechanism, which never can act so as to satisfy his own ideas of what he might be—for he can imagine a state of moral perfection, (as he can imagine a globe formed of diamonds, pearls, and rubies,) though his constitution forbids him to realize it. There ever will, in the best disposed and most disciplined minds, be occasional discrepancies between the amount of temptation and the power summoned for regulation or resistance, or between the stimulus and the mobility of the faculty; and hence those errors, and shortcomings, and excesses, without end, with which the good are constantly finding cause to charge themselves. There is at the same time even here a possibility of improvement. In infancy, the impulses are all of them irregular; a child is cruel, cunning, and false, under the slightest temptation, but in time learns to control these inclinations, and to be habitually humane, frank, and truthful. So is human society, in its earliest stages, sanguinary, aggressive, and deceitful, but in

time becomes just, faithful, and benevolent. To such improvements there is a natural tendency which will operate in all fair circumstances, though it is not to be expected that irregular and undue impulses will ever be altogether banished from the system.

It may still be a puzzle to many, how beings should be born into the world whose organization is such that they unavoidably, even in a civilized country, become malefactors. Does God, it may be asked, make criminals? Does he fashion certain beings with a predestination to evil? He does not do so; and yet the criminal type of brain, as it is called, comes into existence in accordance with laws which the Deity has established. It is not, however, as the result of the first or general intention of those laws, but as an exception from their ordinary and proper action. The production of those evilly disposed beings is in this manner. The moral character of the progeny depends in a general way, (as does the physical character also,) upon conditions of the parents,—both general conditions, and conditions at the particular time of the commencement of the existence of the new being, and likewise external conditions affecting the fœtus through the mother. Now the amount

of these conditions is indefinite. The faculties of the parents, as far as these are concerned, may have oscillated for the time towards the extreme of tensibility in one direction. The influences upon the fœtus may have also been of an extreme and unusual kind. Let us suppose that the conditions upon the whole have been favourable for the development, not of the higher, but of the lower sentiments, and of the propensities of the new being, the result will necessarily be a mean type of brain. Here, it will be observed, God no more decreed an immoral being, than he decreed an immoral paroxysm of the sentiments. Our perplexity is in considering the ill-disposed being by himself. He is only a part of a series of phenomena, traceable to a principle good in the main, but which admits of evil as an exception. We have seen that it is for wise ends that God leaves our moral faculties to an indefinite range of action: the general good results of this arrangement are obvious; but exceptions of evil are inseparable from such a system, and this is one of them. To come to particular illustration—when a people are oppressed, or kept in a state of slavery, they invariably contract habits of lying, for the purpose of deceiving and outwitting their supe-

riors, falsehood being a refuge of the weak under difficulties. What is a habit in parents becomes an inherent quality in children. We are not, therefore, to be surprised when a traveller tells us that black children in the West Indies appear to lie by instinct, and never answer a white person truly, even in the simplest matter. Here we have secretiveness roused in a people to a state of constant and exalted exercise; an over tendency of the nervous energy in that direction is the consequence, and a new organic condition is established. This tells upon the progeny, which comes into the world with secretiveness excessive in strength and activity. All other evil characteristics may be readily conceived as being implanted in a new generation in the same way. And sometimes not one, but several generations, may be concerned in bringing up the result to a pitch which produces crime. It is, however, to be observed, that the general tendency of things is to a limitation, not the extension of such abnormally constituted beings. The criminal brain finds itself in a social scene where all is against it. It may struggle on for a time, but the medium and superior natures are never long at a loss in getting the better of it. The disposal of such beings will always depend

much on the moral state of a community, the degree in which just views prevail with regard to human nature, and the feelings which accident may have caused to predominate at a particular time. Where the mass was little enlightened or refined, and terrors for life or property were highly excited, malefactors have ever been treated severely. But when order is generally triumphant, and reason allowed sway, men begin to see the true case of criminals—namely, that while one large department are victims of erroneous social conditions, another are brought to error by tendencies which they are only unfortunate in having inherited from nature. Criminal jurisprudence, then, addresses itself less to the direct punishment than to the reformation and care-taking of those liable to its attention. And such a treatment of criminals, it may be farther remarked, so that it stop short of affording any encouragement to crime, (a point which experience will determine,) is evidently no more than justice, seeing how accidentally all forms of the moral constitution are distributed, and how thoroughly mutual obligation shines throughout the whole frame of society—the strong to help the weak, the good to redeem and restrain the bad.

The sum of all we have seen of the psychical constitution of man is, that its Almighty Author has destined it, like everything else, to be developed from inherent qualities, and to have a mode of action depending solely on its own organization. Thus the whole is complete on one principle. The masses of space are formed by law; law makes them in due time theatres of existence for plants and animals; sensation, disposition, intellect, are all in like manner developed and sustained in action by law. It is most interesting to observe into how small a field the whole of the mysteries of nature thus ultimately resolve themselves. The inorganic has been thought to have one final comprehensive law, GRAVITATION. The organic, the other great department of mundane things, rests in like manner on one law, and that is—DEVELOPMENT. Nor may even these be after all twain, but only branches of one still more comprehensive law, the expression of a unity, flowing immediately from the One who is First and Last.

PURPOSE AND GENERAL CONDITION OF THE ANIMATED CREATION.

We have now to inquire how this view of the constitution and origin of nature bears upon the condition of man upon the earth, and his relation to supra-mundane things.

That enjoyment is the proper attendant of animal existence is pressed upon us by all that we see and all we experience. Everywhere we perceive in the lower creatures, in their ordinary condition, symptoms of enjoyment. Their whole being is a system of needs, the supplying of which is gratification, and of faculties, the exercise of which is pleasurable. When we consult our own sensations, we find that, even in a sense of a healthy performance of all the functions of the animal economy, God has furnished us with an innocent and

very high enjoyment. The mere quiet consciousness of a healthy play of the mental functions—a mind at ease with itself and all around it—is in like manner extremely agreeable. This negative class of enjoyments, it may be remarked, is likely to be even more extensively experienced by the lower animals than by man, at least in the proportion of their absolute endowments, as their mental and bodily functions are much less liable to derangement than ours. To find the world constituted on this principle is only what in reason we would expect. We cannot conceive that so vast a system could have been created for a contrary purpose. No averagely constituted human being would, in his own limited sphere of action, think of producing a similar system upon an opposite principle. But to form so vast a range of being, and to make being everywhere a source of gratification, is conformable to our ideas of a Creator, in whom we are constantly discovering traits of a nature, of which our own is but a faint and far-cast shadow at the best.

It appears at first difficult to reconcile with this idea the many miseries which we see all sentient beings, ourselves included, occasionally enduring. How, the sage has asked in every age, should a

Being so transcendently kind, have allowed of so large an admixture of evil in the condition of his creatures? Do we not at length find an answer to a certain extent satisfactory, in the view which has now been given of the constitution of nature? We there see the Deity operating in the most august of his works by fixed laws, an arrangement which, it is clear, only admits of the main and primary results being good, but disregards exceptions. Now the mechanical laws are so definite in their purposes, that no exceptions ever take place in that department; if there is a certain quantity of nebulous matter to be agglomerated and divided and set in motion as a planetary system, it will be so with hair's-breadth accuracy, and cannot be otherwise. But the laws presiding over meteorology, life, and mind, are necessarily less definite, as they have to produce a great variety of mutually related results. Left to act independently of each other, each according to its separate commission, and each with a wide range of potentiality to be modified by associated conditions, they can only have effects generally beneficial. Often there must be an interference of one law with another; often a law will chance to operate in excess, or upon a wrong object, and thus evil

will be produced. Thus, winds are generally useful in many ways, and the sea is useful as a means of communication between one country and another; but the natural laws which produce winds are of indefinite range of action, and sometimes are unusually concentrated in space or in time, so as to produce storms and hurricanes, by which much damage is done; the sea may be by these causes violently agitated, so that many barks and many lives perish. Here, it is evident, the evil is only exceptive. Suppose, again, that a boy, in the course of the lively sports proper to his age, suffers a fall which injures his spine, and renders him a cripple for life. Two things have been concerned in the case: first, the love of violent exercise, and second, the law of gravitation. Both of these things are good in the main. Boys, in the rash enterprises and rough sports in which they engage, are only making the first delightful trials of a bodily and mental energy which has been bestowed upon them as necessary for their figuring properly in a scene where many energies are called for, but where the exertion of these powers is ever a source of happiness. By gravitation, all moveable things, our own bodies included, are kept stable on the surface of the earth. But when it

chances that the playful boy loses his hold (we shall say) of the branch of a tree, and has no solid support immediately below, the law of gravitation unrelentingly pulls him to the ground, and thus he is hurt. Now it was not a primary object of gravitation to injure boys; but gravitation could not but operate in the circumstances, its nature being to be universal and invariable. The evil is, therefore, only a casual exception from something in the main good.

The same explanation applies to even the most conspicuous of the evils which afflict society. War, it may be said, and said truly, is a tremendous example of evil, in the misery, hardship, waste of human life, and mis-spending of human energies, which it occasions. But what is it that produces war? Certain tendencies of human nature, as keen assertion of a supposed right, resentment of supposed injury, acquisitiveness, desire of admiration, combativeness, or mere love of excitement. All of these are tendencies which are every day, in a legitimate extent of action, producing great and indispensable benefits to us. Man would be a tame, indolent, unserviceable being without them, and his fate would be starvation. War, then, huge evil though it be, is, after all, but the

exceptive case, a casual misdirection of properties and powers essentially good. God has given us the tendencies for a benevolent purpose. He has only not laid down any absolute obstruction to our misuse of them. That were an arrangement of a kind which he has nowhere made. But he has established many laws in our nature which tend to lessen the frequency and destructiveness of these abuses. Our reason comes to see that war is purely an evil, even to the conqueror. Benevolence interposes to make its ravages less mischievous to human comfort, and less destructive to human life. Men begin to find that their more active powers can be exercised with equal gratification on legitimate objects; for example, in overcoming the natural difficulties of their path through life, or in a generous spirit of emulation in a line of duty beneficial to themselves and their fellow-creatures. Thus, war at length shrinks into a comparatively narrow compass, though there certainly is no reason to suppose that it will be at any early period, if ever, altogether dispensed with, while man's constitution remains as it is. In considering an evil of this kind, we must not limit our view to our own or any past time. Placed upon the earth with faculties prepared to act, but

inexperienced, and with the more active propensities necessarily in great force to suit the condition of the globe, man was apt to misuse his powers much in this way at first, compared with what he is likely to do when he advances into a condition of civilization. In the scheme of providence, thousands of years of frequent warfare, all the so-called glories which fill history, may be but a subordinate consideration. The chronology of God is not as our chronology. See the patience of waiting evinced in the slow development of the animated kingdoms, throughout the long series of geological ages. Nothing is it to him that an entire goodly planet should, for an inconceivable period, have no inhabiting organisms superior to reptiles. Nothing is it to him that whole astral systems should be for infinitely longer spaces of time in the nebular embryo, unfit for the reception of one breathing or sentient being out of the myriad multitudes who are yet to manifest his goodness and his greatness. Progressive, not instant effect is his sublime rule. What, then, can it be to him that the human race goes through a career of impulsive acting for a few thousand years? The cruelties of ungoverned anger, the tyrannies of the rude and proud over the humble

and good, the martyr's pains, and the patriot's despair, what are all these but incidents of an evolution of superior being which has been pre-arranged and set forward in independent action, free within a certain limit, but in the main constrained, through primordial law, to go on ever brightening and perfecting, yet never, while the present dispensation of nature shall last, to be quite perfect!

The sex passion in like manner leads to great evils. Providence has seen it necessary to make very ample provision for the preservation and utmost possible extension of all species. The aim seems to be to diffuse existence as widely as possible, to fill up every vacant piece of space with some sentient being to be a vehicle of enjoyment. Hence this passion is conferred in great force. But the relation between the number of beings, and the means of supporting them, is only on the footing of general law. There may be occasional discrepancies between the laws operating for the multiplication of individuals, and the laws operating to supply them with the means of subsistence, and evils will be endured in consequence, even in our own highly favoured species. But against all these evils, and against those numberless vexations which

have arisen in all ages from the attachment of the sexes, place the vast amount of happiness which is derived from this source—the basis of the whole circle of the domestic affections, the sweetening principle of life, the prompter of all our most generous feelings, and even of our most virtuous resolves and exertions—and every ill that can be traced to it is but as dust in the balance. And here, also, we must be on our guard against judging from what we see in the world at a particular era. As reason and the higher sentiments of man's nature increase in force, this passion is put under better regulation, so as to lessen many of the evils connected with it. The civilized man is more able to give it due control; his attachments are less the result of impulse; he studies more the weal of his partner and offspring. There are even some of the resentful feelings connected in early society with love, such as hatred of successful rivalry, and jealousy, which almost disappear in an advanced state of civilization. The evils springing, in our own species at least, from this passion, may therefore be an exception mainly peculiar to a particular term of the world's progress, and which may be expected to decrease greatly in amount.

With respect, again, to disease, so prolific a cause of suffering to man, the human constitution is merely a complicated but regular process in electro-chemistry, which goes on well, and is a source of continual gratification, so long as nothing occurs to interfere with it injuriously, but which is liable every moment to be deranged by various external agencies, when it becomes a source of pain, and, if the injury be severe, ceases to be capable of retaining life. It may be readily admitted that the evils experienced in this way are very great; but, after all, such experiences are no more than occasional, and not necessarily frequent —exceptions from a general rule of which the direct action is to confer happiness. The human constitution might have been made of a more hardy character; but we always see hardiness and insensibility go together, and it may be of course presumed that we only could have purchased this immunity from suffering at the expense of a large portion of that delicacy in which lie some of our most agreeable sensations. Or man's faculties might have been restricted to definiteness of action, as is greatly the case with those of the lower animals, and thus we should have been equally safe from the aberrations which lead to disease; but in that

event we should have been incapable of acting to so many different purposes as we are, and of the many high enjoyments which the varied action of our faculties places in our power: we should not, in short, have been human beings, but merely on a level with the inferior animals. Thus, it appears, that the very fineness of man's constitution, that which places him in such a high relation to the mundane economy, and makes him the vehicle of so many exquisitely delightful sensations—it is this which makes him liable to the sufferings of disease. It might be said, on the other hand, that the noxiousness of the agencies producing disease might have been diminished or extinguished; but the probability is, that this could not have been done without such a derangement of the whole economy of nature as would have been attended with more serious evils. For example—a large class of diseases are the result of effluvia from decaying organic matter. This kind of matter is known to be extremely useful, when mixed with earth, in favouring the process of vegetation. Supposing the noxiousness to the human constitution done away with, might we not also lose that important quality which tends so largely to increase the food raised from the ground? Perhaps (as

has been suggested) the noxiousness is even a matter of special design, to induce us to put away decaying organic substances into the earth, where they are calculated to be so useful. Now man has reason to enable him to see that such substances are beneficial under one arrangement, and noxious in the other. He is, as it were, commanded to take the right method in dealing with them. In point of fact, men do not always take this method, but allow accumulations of noxious matter to gather close about their dwellings, where they generate fevers and agues. But their doing so may be regarded as only a temporary exception from the operation of mental laws, the general tendency of which is to make men adopt the proper measures. And these measures will probably be in time universally adopted, so that one extensive class of diseases will be altogether or nearly abolished.

Another large class of diseases spring from mismanagement of our personal economy. Eating to excess, eating and drinking what is noxious, disregard to that cleanliness which is necessary for the right action of the functions of the skin, want of fresh air for the supply of the lungs, undue, excessive, and irregular indulgence of the mental affections, are all of them recognised modes of

creating that derangement of the system in which disease consists. Here also it may be said that a limitation of the mental faculties to definite manifestations (*vulgo*, instincts) might have enabled us to avoid many of these errors; but here again we are met by the consideration that, if we had been so endowed, we should have been only as the lower animals are, wanting that transcendently higher character of sensation and power, by which our enjoyments are made so much greater. In making the desire of food, for example, with us an indefinite mental manifestation, instead of the definite one, which it mainly is amongst the lower animals, the Creator has given us a means of deriving far greater gratifications from food (consistently with health) than the lower animals generally appear to be capable of. He has also given us reason to act as a guiding and controlling power over this and other propensities, so that they may be prevented from becoming causes of malady. We can see that excess is injurious, and are thus prompted to moderation. We can see that all the things which we feel inclined to take are not healthful, and are thus exhorted to avoid what are pernicious. We can also see that a cleanly skin and a constant supply of

pure air are necessary to the proper performance of some of the most important of the organic functions, and thus are stimulated to frequent ablution, and to a right ventilation of our parlours and sleeping apartments. And so on with the other causes of disease. Reason may not operate very powerfully to these purposes in an early state of society, and prodigious evils may therefore have been endured from diseases in past ages; but these are not necessarily to be endured always. As civilization advances, reason acquires a greater ascendancy; the causes of the evils are seen and avoided; and disease shrinks into a comparatively narrow compass. The experience of our own country places this in a striking light. In the middle ages, when large towns had no police regulations, society was at frequent intervals scourged by pestilence. The third of the people of Europe are said to have been carried off by one epidemic. Even in London the annual mortality has greatly sunk within a century. The improvement in human life, which has taken place since the construction of the Northampton tables by Dr. Price, is equally remarkable. Modern tables still shew a prodigious mortality among the young in all civilized countries—evidently a result of some preva-

lent error in the usual modes of rearing them. But to remedy this evil there is the sagacity of the human mind, and the sense to adopt any reformed plans which may be shewn to be necessary. By a change in the management of an orphan institution in London, during the last fifty years, an immense reduction in the mortality took place. We may of course hope to see measures devised and adopted for producing a similar improvement of infant life throughout the world at large.

In this part of our subject, the most difficult point certainly lies in those occurrences of disease where the afflicted individual has been in no degree concerned in bringing the visitation upon himself. Daily experience shews us infectious disease arising in a place where the natural laws in respect of cleanliness are neglected, and then spreading into regions where there is no blame of this kind. We then see the innocent suffering equally with those who may be called the guilty. Nay, the benevolent physician who comes to succour the miserable beings whose error may have caused the mischief, is sometimes seen to fall a victim to it, while many of his patients recover. We are also only too familiar with the transmission of diseases from erring parents to innocent children, who ac-

cordingly suffer, and perhaps die prematurely, as it were for the sins of others. After all, however painful such cases may be in contemplation, they cannot be regarded in any other light than as exceptions from arrangements, the general working of which is beneficial.

With regard to the innocence of the suffering parties, there is one important consideration which is pressed upon us from many quarters—namely, that moral conditions have not the least concern in the working of these simply physical laws. These laws proceed with an entire independence of all such conditions, and desirably so, for otherwise there could be no certain dependence placed upon them. Thus it may happen that two persons ascending a piece of scaffolding, the one a virtuous, the other a vicious man, the former, being the less cautious of the two, ventures upon an insecure place, falls, and is killed, while the other, choosing a better footing, remains uninjured. It is not in what we can conceive of the nature of things, that there should be a special exemption from the ordinary laws of matter, to save this virtuous man. So it might be that, of two physicians, attending fever cases, in a mean part of a large city, the one, an excellent citizen, may stand in such a position with respect

to the beds of the patients as to catch the infection, of which he dies in a few days, while the other, a bad husband and father, and who, unlike the other, only attends such cases with selfish ends, takes care to be as much as possible out of the stream of infection, and accordingly escapes. In both of these cases man's sense of good and evil—his faculty of conscientiousness—would incline him to destine the vicious man to destruction and save the virtuous. But the Great Ruler of Nature does not act on such principles. He has established laws for the operation of inanimate matter, which are quite unswerving, so that, when we know them, we have only to act in a certain way with respect to them, in order to obtain all the benefits and avoid all the evils connected with them. He has likewise established moral laws in our nature, which are equally unswerving, (allowing for their wider range of action,) and from obedience to which unfailing good is to be derived. But the two sets of laws are independent of each other. Obedience to each gives only its own proper advantage, not the advantage proper to the other. Hence it is that virtue forms no protection against the evils connected with the physical laws, while, on the other hand, a man skilled in, and attentive to these, but

unrighteous and disregardful of his neighbour, is in like manner not protected by his attention to physical circumstances from the proper consequences of neglect or breach of the moral laws.

Thus it is that the innocence of the party suffering for the faults of a parent, or of any other person or set of persons, is evidently a consideration quite apart from that suffering.

The whole question of evil, a puzzle throughout all ages, only becomes explicable when we receive and study the system of a mundane government by law. There is no need for considering it as a detraction from either the power or the goodness of God. The dispensation under which we live has been constituted by him on the principle of law; but this is not necessarily to imply that either his goodness or his power is to stop at this point. That such, however, is the character of the pageantry of worldly events now passing, is the only idea we can arrive at when we approach the question without prejudice. How else should it be that in any case the guilty flourish and the innocent suffer? How else should it be that men often endure bitter woe and pain while prosecuting the noblest objects? How else should we ever see so simple an event as the following, which meets my eyes in the jour-

nals, while these sheets pass through the press:—A multitude of poor Irish emigrants are embarked in a canal boat, about to leave their native district for a port whence they are to sail for America. At the moment of parting, they crowd to one side, to shake hands for the last time with their friends. The vessel is overbalanced and turned upon its side. Of the multitude thrown into the water, seven are taken up dead. Here, an action rather amiable and laudable than otherwise, leads to the loss of life,—a pure evil, unmixed with good. It is impossible to imagine such a transaction occuring under the immediate direction of the Deity; it would be profaning human nature to attribute any such act to the immediate command or interference of a man. But there is no difficulty in understanding how such occasional evils should take place in the course of a chain of causes which only proceed in consequence of a remote and general impulse designed in the main for good.

Evil, indeed, is one of the strongest proofs that could be desired for the reality of this system. We see it in one of its most familiar forms in the destructive animals. An innocent little bird in the claws of the cruel hawk—a poor stag grasped by the ruthless boa—a lamb in the fangs of the wolf—

can we imagine a form of misery greater than the fate of these animals? Yet millions of such creatures perish in this manner annually, and have so done since long before there existed a human heart to pine or break with its more sentimental, but not less real wretchedness. Upon no theory can this be understood except upon that of an economy governed by general laws. The carnivorous animals are simply the police and undertakers of the inferior creation, preventing their too great increase, and clearing off all such as grow weakly and die, ere they can become in any degree a burden to themselves or a nuisance to other creatures. For these functions the destructive tribes have been expressly organized, and their organization of course is of divine appointment. Constituted as we are, we cannot suppose a plan involving so much suffering to have been adopted except with a view to that independency, or completeness within itself, which is here argued for as the manner in which the Deity's operations on earth are revealed to us. He has endowed the families which enjoy his bounties with an almost indefinite fecundity, that enjoyment may be as widely diffused as possible; but the limitation of the results of this fecundity within the line necessary according to circumstances, were

no right employment for himself. The object is accomplished, in a befitting manner, by his ordaining that certain other animals shall have endowments sure so to act as to bring the rest of animated beings to a proper balance. And the object is accomplished well; insomuch that we never hear of any but the most partial and transient discrepancy between the volume of inferior animal life and the power appointed for its regulation. Even in this painful chapter of nature, we are forced to acknowledge that, upon the theory of law, every thing is very good.

Another proof, or rather another branch of the same proof, lies in the relation of the individual to the mass, as far as endowment and destiny are concerned. We see, for example, powerful impulses in human nature, which often occasion great inconveniences to those yielding to them. But such impulses are in the main necessary. Destructive, in many cases, to the individual, they are conservative with respect to the totality. What is this but an appointment to render the machine in that respect a self-acting one? Many of the confusions of the moral scene might be thus explained; but it is also to be observed that such impulses are not sent alone—they come in com-

pany with intelligence and moral emotion, powers continually tending more and more to soften and regulate their action.

Nor are any of the ordinary evils of our world altogether unmixed. God, contemplating apparently the unbending action of his great laws, has established others which appear to be designed to have a compensating, a repairing, and a consoling effect. Suppose, for instance, that, from a defect in the power of development in a mother, her offspring is ushered into the world destitute of some of the most useful members, or blind, or deaf, or of imperfect intellect, there is ever to be found in the parents and other relatives, and in the surrounding public, a sympathy with the sufferer, which tends to make up for the deficiency, so that he is in the long run not much a loser. Indeed, the benevolence implanted in our nature seems to be an arrangement having for one of its principal objects to cause us, by sympathy and active aid, to remedy the evils unavoidably suffered by our fellow-creatures in the course of the operation of the other natural laws. And even in the sufferer himself, it is often found that a defect in one point is made up for by an extra power in another. The blind come to have a sense of

touch much more acute than those who see. Persons born without hands have been known to acquire a power of using their feet for a number of the principal offices usually served by that member. I need hardly say how remarkably fatuity is compensated by the more than usual regard paid to the children born with it by their parents, and the zeal which others usually feel to protect and succour such persons. In short, we never see evil of any kind take place where there is not some remedy or compensating principle ready to interfere for its alleviation. And there can be no doubt that in this manner suffering of all kinds is very much relieved.

We may, then, regard the globes of space as theatres designed for the residence of animated sentient beings, placed there with this as their first and most obvious purpose — to be sensible of enjoyments from the exercise of their faculties in relation to external things. The faculties of the various species are very different, but the happiness of each depends on the harmony there may be between its particular faculties and its particular circumstances. For instance, place the small-brained sheep or ox in a good pasture, and it fully enjoys this harmony of relation; but man, having

many more faculties, cannot be thus contented. Besides having a sufficiency of food and bodily comfort, he must have entertainment for his intellect, whatever be its grade, objects for the domestic and social affections, objects for the sentiments. He is also a progressive being, and what pleases him to-day may not please him to-morrow; but, in each case he demands a sphere of appropriate conditions in order to be happy. By virtue of his superior organization, his enjoyments are much higher and more varied than those of any of the lower animals; but the very complexity of circumstances affecting him renders it at the same time unavoidable, that his nature should be often inharmoniously placed and disagreeably affected, and that he should therefore be unhappy. Still, unhappiness amongst mankind is the exception from the rule of their condition, and an exception which is capable of almost infinite diminution, by virtue of the improving reason of man, and the experience which he acquires in working out the problems of society.

To secure the immediate means of happiness, it would seem to be necessary for men first to study with all care the constitution of nature; and, secondly, to accommodate themselves to that con-

stitution, so as to obtain all the realizable advantages from acting conformably to it, and to avoid all likely evils from disregarding it. It will be of no use to sit down and expect that things are to operate of their own accord, or through the direction of a partial deity, for our benefit; equally so were it to expose ourselves to palpable dangers, under the notion that we shall, for some reason, have a dispensation or exemption from them: we must endeavour so to place ourselves, and so to act, that the arrangements which Providence has made impartially for all may be in our favour, and not against us; such are the only means by which we can obtain good and avoid evil here below. And, in doing this, it is especially necessary that care be taken to avoid interfering with the like efforts of other men, beyond what may have been agreed upon by the mass as necessary for the general good. Such interferences, tending in any way to injure the body, property, or peace of a neighbour, or to the injury of society in general, tend very much to reflect evil upon ourselves through the re-action which they produce in the feelings of our neighbour and of society, and also the offence which they give to our own conscientiousness and benevolence. On the other hand,

when we endeavour to promote the efforts of our fellow-creatures to attain happiness, we produce a re-action of the contrary kind, the tendency of which is towards our own benefit. The one course of action tends to the injury, the other to the benefit of ourselves and others. By the one course, the general design of the Creator towards his creatures is thwarted; by the other it is favoured. And thus we can readily see the most substantial grounds for regarding all moral emotions and doings as divine in their nature, and as a means of rising to and communing with God. Obedience is not selfishness, which it would otherwise be—it is worship. The merest barbarians have a glimmering sense of this philosophy, and it continually shines out more and more clearly as men advance in intelligence. Nor are individuals alone concerned here. The same rule applies as between one great body or class of men and another, and also between nations. Thus, if one set of men keep others in the condition of slaves — this being a gross injustice to the subjected party, the mental manifestations of that party to the masters will be such as to mar the comfort of their lives; the minds of the masters themselves will be degraded by the association

with beings so degraded; and thus, with some immediate or apparent benefit from keeping slaves, there will be in a far greater degree an experience of evil. So also, if one portion of a nation, engaged in a particular department of industry, grasp at some advantages injurious to the other sections of the people, the first effect will be an injury to those other portions of the nation, and the second a re-active injury to the injurers, making their guilt their punishment. And so when one nation commits an aggression upon the property or rights of another, or even pursues towards it a sordid or ungracious policy, the effects are sure to be redoubled evil from the offended party. All of these things are under laws which make the effects, on a large range, absolutely certain; and an individual, a party, a people, can no more act unjustly with safety, than I could with safety place my leg in the track of a coming wain, or attempt to fast thirty days. We have been constituted on the principle of only being able to realize happiness for ourselves when our fellow-creatures are also happy; we must therefore both do to others only as we would have others to do to us, and endeavour to promote their happiness as well as our own, in order to find ourselves truly comfortable

in this field of existence. These are words which God speaks to us as truly through his works, as if we heard them uttered in his own voice from heaven.

Whether the human race will ever advance far beyond its present position in intellect and morals, is the last question belonging to the scientific part of our subject. It is one which has engaged much attention, but never appeared likely to approach a settlement, perhaps from the elements for its discussion being hitherto so defective. When judged by the general light arising from the hypothesis of development, we may safely pronounce that the human type is likely yet to experience considerable improvements, though it may be many centuries before a decided change will take place. A progression resembling development may be traced in human nature, both in the individual and in large groups of men. The individual is in childhood under the influence of the propensities and instinctive aptitudes; in youth, he is swayed by marvellousness, the love of the beautiful, the imaginative; in full maturity, he passes under (comparatively) the domination of reason. In perfect analogy, a nation is at first impulsive and unreasoning; afterwards it is conducted by the second class of senti-

ments, (the age of mythologies, hierocracies, man and idea worships;) finally, its institutions begin to approximate to an accurate regard for what is convenient and profitable, under the control of justice and humanity. The advance of knowledge favours the progress of the moral conditions, and in improved moral conditions knowledge becomes more sound. In tolerably favourable circumstances, this tendency onward never fails to make itself visible; and it is evident that, though many nations seem nearly stationary and others appear to retrograde, there is always a progress in some place, so that no long space of time ever elapses without showing, upon the whole, a certain advance. Now all this is quite in conformity with what we have seen of the progress of organic creation. It seems but the minute hand of a watch, of which the hour hand is the transition from species to species. Knowing what we do of that latter transition, the possibility of a decided and general retrogression of the highest species towards a meaner type is scarce admissible, but a forward movement seems anything but unlikely. This view is favoured even by zoological science. We there see order after order of animals, from the bottom of the scale upwards, consisting of many genera, each

of these again presenting various species, until we come to the highest order of all—BIMANA; and behold of this order but one genus—nay, but one species to represent that genus, namely, Man! Take any of the highest orders next to man—the Lemuridæ, the Vespertilionidæ, the Quadrumana, and into what multitudes of species do we find them varying! The Bimana alone is *of one species.* For this no shadow of a zoological reason can be presented. It is supported by none of the analogies of nature, but, on the contrary, is in decided contradiction to them, that there should be but one species of the highest type of animated being. If species are determined by circumstances in external nature, we should rather expect to see man bourgeoning into great variation; for man is the being of all beings most various in his destiny with respect to such circumstances. Yet so the fact is —man is of but one species. The zoological series appears here, as it were, broken short, or interrupted in its progress towards a general symmetry. Is not this a strong indication of further progress in development being designed? Is not the right explanation simply this—that the animated creation is seen by us at *a particular point in its progress?* —a progress yet to be continued. To this conclu-

sion, all our knowledge of the past external conditions of the earth conduces. We there see ages marked by rock formations, and a succession of new animals in shadowy conformity with these; but the rock formations and all the associated conditions make no stoppage or marked change at the time of man's appearance. He comes in the course of them, and goes—is still going along, in accordance with them. He is only a new guest, who has entered and sat down at a feast where other guests were before him, and which goes on and on continually: may there not be other guests to come and take their places at this perennial banquet of the High and Bountiful Master? Meaning by other guests, beings, not descending, (as common genealogical language would have it,) but *ascending*, from the now living Mankind,—possessing a superior development of the human character in accordance with the better external conditions which shall then have come into play,—favoured latter children of Nature, who have not lived till the throes and troubles of her maternal state were past. But is the improvement of these conditions to be left to the advance of physical nature, as that was seen before the existence of man? I suspect not. When man came upon the scene, a new agency was evi-

dently added to those formerly operating to this effect. Men, by the work of their thoughtful brains and busy hands, modify external nature in a way never known before. Under the operations of tillage, of mechanism, of building, making, and inventing; of those applications of natural powers and forces which human wit turns to account in so many ways; of all the results of social experience, of knowledge, and of arrangement; the earth tends to become a much serener field of existence than it was in the earlier ages of man's history. Its progress in this respect may not be clearly seen at a particular time, through the obscuring effect of temporary and accidental causes; but that the tendency of the physical improvements wrought by man upon the surface, and of the mechanic movements which he sets agoing for the saving of his own labour, is to improve the daily comforts, and allow room for the intellectual and moral advancement of earth's children, cannot be denied without something like flying in the face of Providence itself. These improvements, then, thus partly wrought out by the exertions of the present race, I conceive as at once preparations for, and causes of, the *possible development* of higher types of humanity,—beings less strong in the impulsive parts of our nature,

physical nature giving less matter for that nature to contend with and subdue to its needs,—more strong in the reasoning and the moral, because there will be less of the opposite to keep these in check,—more fitted for the delights of social life, because society will then present less to dread and more to love. This is but a speculation—some will call it a dream; but I certainly would not have brought it forward here, if there were not some countenance for it in what we know of nature and her history. As a mere speculation resting on that knowledge, and possessing the further recommendation of being agreeable to our best feelings, I leave it to the judgment of the reader.

The history and constitution of the world have now been explained according to the best lights which a humble individual has found within the reach of his perceptive and reasoning faculties. We have seen a system in which all is regularity and order, and all flows from and is obedient to a divine code of laws of unbending operation. We are to understand from what has been laid before us, that man, with his varied mental powers and impulses, is a natural problem, of which the elements can be taken cognizance of by science, and

that all the secular destinies of our race, from generation to generation, are but evolutions from a primal arrangement in the counsels of Deity. To many, at first sight, it is apt to appear as a dreary view of the divine economy of our world, as if it placed God at an immeasurable distance from his creatures, and left them without refuge or remedy from the numberless ills that "flesh is heir to," and which no one can hope altogether to escape. But, in reality, God may be presumed to be revealed to us in every one of the phenomena of the system, in the suspension of globes in space, in the degradation of rocks and the upthrowing of mountains, in the development of plants and animals, in each movement of our minds, and in all that we enjoy and suffer, seeing that, the system requiring a sustainer as well as an originator, he must be continually present in every part of it, albeit he does not permit a single law to swerve in any case from its appointed course of operation. Thus, we may still feel that He is the immediate breather of our life and ruler of our spirits, that we may, by rightly directed thought, come into communion with him, and feel that, even when his penal ordinances are enforced upon us, his hand and arm are closely about us. Nor is this all. It

may be that, while we are committed to take our chance in a natural system of undeviating operation, and are left, with apparent ruthlessness, to endure the consequences of every collision into which we knowingly or unknowingly come with each of its regulations, there is a system of Mercy and Grace behind the screen of nature, towards which we stand in a peculiar class of relations, which is capable of compensating for all casualties endured here, and whose very largeness is what makes these casualties a matter of indifference to God. For the existence of such a system, the actual constitution of nature is indeed a powerful argument. The reasoning may proceed thus:—the system of nature assures us that benevolence is a leading principle in the Divine Mind. But that system is at the same time deficient in a means of making this benevolence of invariable operation. To reconcile this to the character of the Deity, it is necessary to suppose that the present system is but a part of a whole, a stage in a Great Progress, and that the Redress is in reserve. Another argument here occurs—the economy of nature, beautifully arranged and vast in its extent as it is, does not satisfy even man's idea of what might be; he feels that, if this multiplicity of

theatres for the exemplification of such phenomena as we see on earth were to go on for ever unchanged, it would not be worthy of the Being capable of creating it. An endless monotony of human generations, with their humble thinkings and doings, even though liable to a certain improvement, seems an object beneath that august Being. But the mundane economy might be very well as a portion of some greater phenomenon, the rest of which was yet to be evolved. It therefore appears that our system, though it may at first appear at issue with other doctrines in esteem amongst mankind, tends to come into harmony with them, and even to give them support. I would say, in conclusion, that, even where the two above arguments may fail of effect, there may yet be a faith derived from this view of nature sufficient to sustain us under all sense of the imperfect happiness, the calamities, the woes, and pains of this sphere of being. For let us but fully and truly consider what a system is here laid open to view, and we cannot well doubt that we are in the hands of One who is both able and willing to do us the most entire justice. And in this faith we may well rest at ease, even though life should have been to us but a protracted disease, or though

every hope we had built on the secular materials within our reach were felt to be melting from our grasp. Thinking of all the contingencies of this world as to be in time melted into or lost in the greater system, to which the present is only subsidiary, let us wait the end with patience, and be of good cheer.

NOTE CONCLUSORY.

THUS ends a book, composed in solitude, and almost without the cognizance of a single fellow-being, as nearly as possible for the sole purpose of improving the knowledge of mankind, and through that medium, their happiness. For reasons best to be appreciated by myself, my name is retained in its original obscurity, and, in all probability, will never be generally known. I do not expect that any word of praise which the work may elicit shall ever be responded to by me; or that any word of censure shall ever be parried or deprecated. *Sine me*—I may say so far more truly than did the lorn exile of the Euxine—it goes forth to take its chance of instant oblivion, or of a long and active course of usefulness in the world. Neither contingency can be of

any importance to me beyond the regret or the satisfaction which may be imparted by my sense of a lost or a realized benefit to my fellow-creatures. The book, as far as I am aware, is the first attempt to connect the natural sciences into a history of creation, and thence to eliminate a view of nature as one grand system of causation. As a first effort towards a task so much above ordinary aspirations, it must necessarily be in some measure crude and unsatisfactory, even overlooking errors of detail justly attributable to my defective knowledge.* Yet I have thought that the time was come for attempting to weave a great generalization out of the truths already established, or likely soon to be so—not that these were to be held as absolutely sufficient for the perfect completion of such an object, but that it is well, at certain times, to make advances into the field of speculation, in order that a direction may be given for the acquisition of new facts. If my hypothesis shall appear to be in the

* In later editions a few alterations and omissions have been made, either because of doubts which had entered my mind with regard to the passages concerned, or merely because it appeared advisable to remove out of the way illustrations or arguments which had been made the grounds of sweeping objections, while in reality they were all but indifferent to the general question.

main a reflection of natural truth, I anticipate that attention will be drawn to dubious points; observations will be made, and discussions will take place; and in the long run, we shall find we have made a movement, and that towards a settlement of some of the greatest questions affecting humanity.

My sincere desire in the composition of the book was to give what upon mature reflection I conceive to be the true view of nature, with as little vexatious collision as possible with existing beliefs, whether philosophical or religious. I have made little reference to any doctrines of the latter kind which may be thought inconsistent with mine, because to do so would have been to enter upon questions for the settlement of which our knowledge is not yet ripe. Let the reconciliation of whatever is true in my views with whatever is true in other systems come about in the fulness of calm and careful inquiry. I cannot but here remind the reader of what Dr. Whewell has remarked in his History of the Inductive Sciences, and Dr. Wiseman exemplified strikingly in his lectures, how different new philosophic doctrines are apt to appear after we have become familiar with them. Geology at first seems in-

consistent with the authority of the Mosaic record. A storm of unreasoning indignation rises against its teachers. In time, its truths, being found quite irresistible, are admitted, and mankind continue to regard the Scriptures with the same respect as before. So also with several other sciences. Now the only objection that can be made on such ground to this book, is, that it brings forward some new hypotheses, at first sight, like geology, not in perfect harmony with that record, and arranges these, with some associated facts, into a system which partakes of the same character. But may not the sacred text, on a liberal interpretation, or with the benefit of new light reflected from nature, or derived from learning, be shewn to be as much in harmony with the novelties of this volume as it has been with geology and natural philosophy? What is there in the laws of organic creation more startling to the candid theologian than in the Copernican system or the natural formation of strata? And if the whole series of facts is true, why should we shrink from inferences legitimately flowing from it? Is it not a wiser course, since reconciliation has come in so many instances, still to hope for it, still to go on with our new truths, trusting that they also will in time

be found harmonious with all others? Thus we avoid the damage which the very appearance of an opposition to natural truth is calculated to inflict on any system presumed to require such support. Thus we give, as is meet, a respectful reception to what is revealed through the medium of nature, at the same time that we fully reserve our reverence for all we have been accustomed to hold sacred, not one tittle of which it may ultimately be found necessary to alter.

THE END.

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